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OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

NINETY-SIXTH CONGRESS

SECOND SESSION

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OVERSIGHT OF OSTP

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OFFICE OF SCIENCE AND TECHNOLOGY POLICY

FRIDAY, SEPTEMBER 19, 1980

U.S. SENATE, COMMITTEE ON
COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, D.C.

The subcommittee met at 9:37 a.m. in room 235 of the Russell Senate Office Building; Hon. Adlai E. Stevenson (Chairman of the subcommittee) presiding.

Senator STEVENSON. The subcommittee will come to order. This morning we continue our annual oversight hearings of OSTP and implementation of the Science and Technology Policy Act. The subcommittee will consider the administration's 5-year outlook and the second annual report on science and technology. We also have a report by the GAO evaluating OSTP activities, in particular its strategic planning, which also will be the subject of this hearing.

Senator Schmitt?

Senator SCHMITT. I have no statement.

Senator STEVENSON. Senator Cannon?

OPENING STATEMENT BY THE CHAIRMAN

The CHAIRMAN. I think in this hearing it would be appropriate to reflect upon the science and technology policy accomplishments of the past 3 years, as well as looking forward to future issues. Three and a half years ago, the Committee on Commerce, Science, and Transportation was given jurisdiction for matters pertaining to science, engineering, and technology research and development policy.

As part of its oversight responsibility, the committee can review all matters relating to science and technology. To handle this responsibility, the committee formed a new Subcommittee on Science, Technolgy, and Space, and Senator Adlai Stevenson of Illinois became its first chairman.

Senator Stevenson has distinguished himself in carrying out the responsibilities of the subcommittee. He has been the leader in developing the national agenda for science and technology, and as a result of his efforts the subcommittee has been instrumental in advancing industrial innovation initiatives, constructing a national space policy, and overseeing the U.S. space program and promoting international cooperation through science and technology.

The subcommittee addresses diverse issues like national materials policy, recombinant DNA research, patent policy, cooperative industry-university-government R. & D., civilian Earth remote

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sensing, climate change, earthquake hazards mitigation, automotive technology, and many others.

While Senator Stevenson will be retiring at the end of this Congress, the efforts he initiated will continue. Much still needs to be done in such areas as space policy and industrial innovation. These are areas of personal interest to me and are important to others on the committee.

I commend Senator Stevenson's work in these areas and want to assure him and others that we will continue this valuable work. I congratulate him for the fine job that he has done for us.

Senator STEVENSON. Thank you, Senator Cannon, for those charitable comments. The efforts you refer to are your efforts and also Senator Schmitt's efforts. This has been a joint enterprise. I am confident it will continue. All of the subjects that you mentioned and many more are also within the purview of OSTP. I have, through the 3 years that this subcommittee has existed, experienced some disappointments, many satisfactions, and throughout it all a growing respect for our first witness and for his overworked crew in OSTP.

It is a great pleasure for me this morning to recognize the Director of the Office of Science and Technology, Dr. Frank Press. And I will invite him and all of the witnesses to summarize, if possible, their full statements. The prepared statement will be entered in the record.

STATEMENT OF DR. FRANK PRESS, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY; ACCOMPANIED BY RICHARD MESERVE; PHILIP SMITH; DENIS PRAGER; AND BENJAMIN HUBERMAN

Dr. PRESS. I want to state my admiration for the wisdom and leadership you have brought to this committee during your distinguished tenure as chairman. I think you can be proud of the impact you have had on Federal science, technology and space programs and policies over this period of time. It has been rewarding for me to work with you over the past 3½ years, and I look forward to continuing to know you as a friend.

Senator STEVENSON. Thank you.

Dr. PRESS. Over the past 3½ years, I have endeavored to institutionalize the Office of Science and Technology Policy—OSTP—as an office capable of fulfilling congressional expectations while meeting the science and technology advisory needs of the President and his Executive Office. Throughout, I have felt that we were partners in this enterprise.

I see such a partnership as vital to the success of OSTP and to the strength of the Federal leadership in research and development. For this reason, we have made every effort to cooperate with this committee and with other committees concerned with specific scientific and technological issues. In addition to our regular appearances before the oversight committees, we have had private consultations with the chairman and with other committee members and have testified often on specific issues when it was felt that our particular policy perspective might prove useful.

As appropriate, we have worked with this committee and with others on the development of legislation of mutual interest; exam-

ples include the climate bill and the recently passed aquaculture bill. Finally, the Science and Technology Message of the President, transmitted to the Congress in March of 1979, described the administration's science and technology policy perspective, highlighted specific initiatives, addressed potential future impacts of scientific and technological advances, and provided a policy framework for congressional consideration of Federal research and development programs as recommended in the President's budget.

In my testimony today, I would like to present to this committee my perspective on the activities and accomplishments of OSTP during my 3½ years as its Director and to take a brief look at emerging issues of the 1980's.

I have with me today my three Associate Directors, Benjamin Huberman, Denis Prager, and Philip Smith, and the OSTP legal counsel, Richard Meserve. They will join me in responding to your questions.

I. OSTP: 1977–80

My discussions in early 1977 with the President and Vice President led to a broad outline of administration policies emphasizing growth in the support of basic research, an increased role for science and technology in regulatory decisionmaking, incentives for technological innovation, and an enhanced role for science and technology in international relations. Extensive conversations with representatives from the academic and industrial sectors helped to indicate the scope and magnitude of the problems faced by these sectors, and to clarify and refine the specific issues within the broader policy areas.

STRENGTHENING U.S. SCIENCE AND TECHNOLOGY

Underlying the administration's science and technology policies and initiatives has been a consistent and intense concern for the strength of the scientific and technological enterprise in this country. My early consultations with Government research and development managers and academic and industrial leaders helped identify the key factors which have formed the basis of our strategy for strengthening U.S. science and technology:

A stable, balanced Federal R. & D. budget;

Enhanced Government support of basic research;

Strengthening of research and development programs within the mission agencies;

Better cooperation among and within the university, industry, and Government sectors;

Support for modernization of university research and development facilities and equipment;

Attention to science and engineering manpower needs.

President Carter's R. & D. budgets have helped compensate for a previous decade of declining Federal support of R. & D. Including the revised fiscal year 1981 President's budget, the administration has proposed approximately 35-percent growth in the support of both R. & D. and basic research over the last 3 years.

This philosophy of support for research as an investment in the Nation's future was reaffirmed on August 27 when President Carter announced his "Economic Program for the Eighties." An

integral part of this program is an expansion by $600 million of Federal support for scientific research and development over the next 2 years. A substantial portion of these funds will go toward increasing the budget authority in the fiscal year 1981 and fiscal year 1982 budgets to assure 3-percent real growth above inflation in Federal spending for basic research.

One of the things we are trying to do, related to the R. & D. budgeting process, is to bring more stability to the research community by longer term planning, and by negotiating a base of support that good researchers can depend on. As we all know, nature does not yield her secrets on the basis of the annual budget cycle. Therefore, there must be more continuity of support to hold together high quality research teams and permit them to carry out important long-term scientific investigations.

The passage of the multiyear authorization legislation by the Senate this year would have administration support. If we can facilitate enactment of the bill originating in the House, we wish to do so.

Let me turn now to some nonbudgetary matters.

Early in the administration, we initiated studies of the state of basic research in the mission agencies and we took measures to upgrade research. We have had success in many areas—creating, and subsequently strengthening, a strong Office of Energy Research in the new Department of Energy, a Science and Education Administration in the Department of Agriculture, a program of basic research related to automotive technology in the Department of Transportation, and a new focus on basic research in the Department of Defense.

Similar benefits could accrue from a better university connection with other agencies and other sectors of our society. We have been working for this, directly and indirectly, through such mechanisms as competitive grants in agriculture and through university-centered environmental research centers established by EPA.

Nonfiscal resources must also be considered as major factors in the strength of the U.S. scientific and technological enterprise. These include equipment, facilities, and manpower. As Director of OSTP, I have been made increasingly aware of the steady decline in the quality of scientific instrumentation and facilities for research and teaching within our research universities and engineering colleges.

Another critical resource is, of course, scientific and engineering manpower. Because of the rapidly changing needs for various scientific disciplines and engineering specialties, and of the lag-times inherent in the education process, predicting demand and influencing supply of manpower has proven particularly difficult. For this reason, at my recommendation, the President commissioned a study by the Department of Education and the NSF to assess the current and projected supply and demand of science and engineering personnel and to assess the quality and appropriateness of science and engineering education.

It seems increasingly clear that the strength of the U.S. scientific and technological enterprise depends upon close cooperation among the three major R. & D. performers—government, industry, and universities. Bringing about such cooperation is a real challenge

because of the diversity among these sectors. Yet, the potential benefits of increased cooperation among these three sectors in research and development justify the considerable OSTP efforts in this area.

PARTNERSHIP WITH AMERICAN INDUSTRY: INDUSTRIAL INNOVATION

A dominant theme of the meetings I held with industry executives during my first few months as Director of OSTP was the impact of Government policies on industrial innovation. These conversations led me to recommend to the President that he initiate an examination of Government actions to enhance innovation. While there had been previous studies of innovation, these had not engaged Cabinet heads and the President.

The resulting Domestic Policy Review on Innovation, with which you are most familiar, recommended that the President take a number of steps to stimulate innovation. The President's decisions were announced in a message to Congress, delivered in October 1979.

The incorporation of a number of these initiatives into the legislation you have sponsored, Mr. Chairman, will help insure that they go forward effectively.

We realized when the President's innovation initiatives were announced that, from industry's point of view, the most important area affecting industrial innovation was economic policy, particularly Federal tax policy. When the innovation proposals were released, a commitment was made to consider tax incentives for innovation and productivity, as part of future tax proposals.

The economic program announced by the President on August 27 takes the next steps in Government efforts to stimulate industrial innovation and productivity. In addition to the Federal expenditures for research and development, the program encourages longer term investment in capital facilities and measures to induce competitiveness domestically and abroad. Specifically, the program proposes:

A liberalized and simplified form of business tax depreciation to encourage rehabilitation of existing facilities and investment in new plants and equipment;

A partially refundable business tax credit to benefit those businesses—distressed firms in industries such as autos and steel, as well as small businesses just starting up—which have no earnings, yet have substantial investment needs;

A tax credit to offset the increase in the employers share of the social security tax;

A variety of measures to increase exports;

Implementation of initiatives proposed by the White House Conference on Small Business to help in the startup and operation of small businesses;

And creation of a President's Economic Revitalization Board to foster public-private sector cooperation in dealing with the complex issues of industrial policy.

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JOINT GOVERNMENT-INDUSTRY RESEARCH PROGRAMS

OSTP has stimulated development of two research initiatives that affect the pattern of cooperation between the Government and industry and also foster cooperation within industrial sectors. In each case, the objective has been to plan new activities that have substantial prospect for long-term payoff but which would not likely take place without collective cooperation within an industrial sector and between Government and industry.

The first of these is the cooperative automobile research program (CARP) which we have discussed in detail before this committee on other occasions.

A second program for Government cooperation with industry is the ocean margin drilling (OMD) program. This program of frontier research and technological development will enable us to characterize the passive and active continental margins. We have proposed a cost-sharing effort through which the Government and companies in the oil industry each would contribute about $350 million over a 10-year period. This activity, which will go forward if preliminary engineering work now under way shows the project to be feasible, will lead to advanced developments in riser technology and well control to permit drilling in water depths of 3 to 4 kilometers and in the sedimentary rocks to a depth of about 6 kilometers.

These two programs represent significant developments in Government-industry-university cooperation. Each has required a careful study of prospective research and engineering objectives, a clear delineation of appropriate Government and private sector roles, a mutual willingness to explore new patterns of work, and objective examination of antitrust, patent policy, and other issues that have been real or perceived barriers to cooperation. A careful line had to be observed in developing a program satisfactory to industry legal counsels, the Justice Department, and the Federal Trade Commission.

In my dual role as a member of the President's staff and Director of OSTP, with a statutory mandate to coordinate interagency programs, I was able to organize the participation of several Government agencies and to clear the programs through the White House. The CARP and the OMD programs may serve as models for exploring joint ventures in other sectors, which have similar attributes—a high degree of shared private and Government interest, the need to organize cooperation of the major firms of an industry in ways that do not impede competition, and a long term but high rate of return to joint investment. The economic program announced late last month includes a commitment for some additional cooperative intersectoral programs, and we are exploring the possibility of initiating one or two more.

REGULATORY REFORM

Discussions of industrial technology and innovation invariably turn to the regulatory system. Indeed, one of the most striking changes that has taken place in our governmental system over the past two decades has been the rapid growth of regulation to achieve socially desired objectives. In many cases, regulation in-

volves important technological decisions. Air and water pollution control, energy conservation, hazardous waste disposal, occupational health and safety, aircraft safety, and nuclear power safety are prominent examples. It was clear to us early, therefore, that regulatory matters would be a major concern to OSTP.

In the past 4 years, the administration has taken a number of steps to improve the regulatory process. I will not review these here. OSTP focuses on the use of high quality scientific and technological data and improved methods of risk assessment in the regulatory process.

It is true that the fundamental political and, indeed, adversarial nature of the process does not provide an ideal environment in which the technical data from diverse sources may be pooled and objectively examined.

In many cases, the time pressures set by statute, court decisions, or other events do not allow the orderly resolution of technical conflicts. Yet, regulation is one of the many highly complex decisionmaking processes for which scientific and technological judgment must be joined together with economic and other perspectives for their resolution.

For example, an issue of major significance is regulatory treatment of potential carcinogens. As our instrumentation and diagnostic capabilities have improved, we have increasingly discovered that many manmade substances introduced into our environment may be carcinogenic.

However, Government policies for dealing with these problems have been inconsistent. OSTP, therefore, undertook a study analyzing the scientific principles underlying carcinogenic risk assessment and laying out framework for identifying and characterizing chemicals that might pose a carcinogenic risk.

The resulting report was a factor in establishing a uniform Government policy for controlling chemical carcinogens. The agencies agreed to a set of general concepts and principles for use in determining whether a chemical may cause cancer, assessing its risk, setting regulatory practices, and undertaking regulatory actions.

One of the most dramatic developments in all of science is the application to recombinant DNA techniques to many problems of basic biology and to production of needed hormones, vaccines, chemicals, and other pharmaceutical and agricultural products.

The public had been greatly alarmed, 4 years ago, by controversy within the molecular biology community over the safety of such research. A determined effort led by Dr. Donald Fredickson, Director of NIH, and joined by an effective Interagency Committee, including OSTP, brought public health insights, risk assessment experiments, new data, and a more objective attitude to policy discussions.

Congressional hearings also helped air all sides of this complex issue and promote a reasoned assessment of the putative risks involved. The prudent course undertaken has allowed very rapid progress in this work, permitted university and industrial efforts to grow and flourish, and assured workers and environmentalists that great care is, indeed, being exercised through the NIH guidelines and through educational efforts on industrial applications.

Some areas of regulation require a range of tools to evolve a sound policy. For example, OSTP has worked extensively on Government policy regarding the introduction of diesel engines into the passenger car fleet. OSTP encouraged DOE to accelerate and expand its planned diesel health effects program as a complement to EPA's program, and worked with OMB to get its budget approved.

Second, OSTP, with the strong support from the other White House offices, requested DOE, DOT, and EPA to fund jointly a major—$1.3 million—study by the National Academy of Sciences (NAS) to analyze a range of Federal policy alternatives and to insure the soundness of the research programs of both the public and private sectors.

The study is scheduled for completion in December 1980. Whether other measures will be necessary to deal with the possible carcinogenicity of the diesel exhaust will be determined next year after the NAS report is completed and the research programs are further along.

Examples such as these illustrate the valuable contribution of scientifically valid data to the regulatory decisionmaking process and leave little doubt that OSTP will continue to play an important role in improving the Federal regulatory process and in upgrading the quality of scientific analyses employed by regulatory agencies.

HEALTH RESEARCH

Health policy initiatives of this administration have emphasized wider availability of health care services; prevention of injury, disease, and disability; control of health care costs; and expansion of health insurance coverage.

Such health service initiatives generally are not considered to be within the purview of science and technology policy. Yet, their successful development and implementation require decisions informed by the best available scientific information, programs supported by sound basic and applied research, and evaluation and impact assessment based on complete data. OSTP has focused on the scientific and technological issues in health care and identified specific key issues for consideration.

An example is the controversy over the role of new health care technologies in escalating health care costs. Many observers equate the two, singling out specific technologies—for example, computed tomography and coronary artery bypass surgery—as causes of cost inflation.

Cutting wasteful and excessive health care costs without inhibiting technological innovation requires: First, objective analysis of incentives in the system and identification of those which may wrongly reward inappropriate or excessive use of technologies, and second, wise assessment of the safety and efficacy of new technologies. This has been the primary health policy focus of this office.

Basic knowledge of the human organism is fundamental in addressing successfully our difficult health problems. This administration has supported rational growth of our biomedical research enterprise and of its Federal guardian—the National Institutes of Health.

Each year the President has proposed a 10-percent increase in the NIH budget over his request of the previous year. Consistently, Congress has increased the NIH budget, resulting in rapid unplanned growth, with money frequently allocated according to criteria other than the needs and opportunities of the field.

The resulting instability among the various NIH institutes and among our research universities has been particularly damaging to basic research. Accordingly, OSTP has joined with Congress, NIH, the biomedical research community, and OMB to develop a consistent approach to NIH budget growth.

The fiscal year 1981 NIH budget proposes stabilizing the number of new and competing research grants at around 5,000 awards. This approach will provide continuity and stability, especially for individual investigator-initiated research.

AGRICULTURAL POLICY

Advanced agricultural research is vital to our future and that of other nations. Our agricultural productivity must grow to meet ever-increasing domestic and worldwide needs. Yet, our land is producing at its biological limits within the boundaries of present knowledge and technology. Prime agricultural land is being diverted to other uses or to nonfood crops such as energy, fiber, and chemical feedstocks. Our farmers are turning to other occupations. Many agricultural chemicals and practices are being restricted for valid health, safety, and environmental reasons. Lastly, critical agricultural resources such as energy, soil, water, chemicals, and capital are more expensive.

Our agricultural policies emphasize the importance of a strong agricultural research enterprise in increasing agricultural productivity. OSTP has worked closely with the Secretary of Agriculture in stabilizing and increasing agricultural research budgets and in strengthening the management of the Department of Agriculture's research programs.

The DOA Director of Science and Education now is equivalent to an assistant secretary and is a member of the Secretary's budget and policy review group. Program review and evaluation procedures are improved to assure that scarce resources fund the highest quality, most relevant research.

The new DOA competitive research grants program, now in its third year, has been especially successful. This small program supports high priority, basic research in plant science and human nutrition. It has attracted a number of investigators to the field, including many new, young researchers as well as accomplished scientists from other research areas.

The demand in our own country as well as abroad for freshwater and marine plants and animals for food, fiber, and biomass has focused attention on the need to strengthen Government aquaculture research and development activities.

At the direction of the President, OSTP has worked with the relevant agencies and Congress to develop a national aquaculture plan, to study those factors which may constrain the American aquaculture industry, to institutionalize interagency coordination and joint programing, and to develop appropriate and effective aquaculture legislation.

ENERGY AND ENVIRONMENTAL R. & D.

Energy policy goes far beyond the realm of science and technology, encompassing broad economic, political, and social considerations both domestically and internationally. Nevertheless, science and technology are essential components of the solution to our energy problems and ultimately influence all of them.

What alternate energy resources and technologies we choose to pursue, how we develop them over time, what their safety, reliability and environmental impact are, and what bearing they might have on economic policy, national security, and our international relations—all these and other questions are tied to the knowledge and capabilities that flow from our energy research and development.

Our current energy policy emphasizes reliance on a range of energy initiatives. These include conservation and decontrol; synthetic fuels development; the continuing role for nuclear energy with measures to improve safety, to control nuclear weapons proliferation, and to manage radioactive waste; geothermal energy; major expansion of solar energy research and incentives for use of existing solar technology; and long-range resource development in areas such as fusion. In addition, we have significant breeder reactor research and development efforts underway to meet potential future needs.

My staff and I participate in the energy budget review and other activities of the Executive Office where our capabilities in energy research and technology make our participation appropriate. Today I will highlight several of these activities.

As you are aware, the accident at Three Mile Island revealed substantial shortcoming on the part of Government and the utilities in assuring the safety to nuclear power. The President thus established a commission to investigate the accident and its cause.

This commission, chaired by John Kemeny, made some 44 recommendations for change, including modification of the structure and procedures of the NRC, improved training of operating personnel, and greatly strengthened emergency planning and response, among others.

The President has adopted virtually all these recommendations. The reorganization plan submitted to the Congress should serve to assist in the development of a unified and more reliable nuclear safety regulatory program. The President's nominee to become the next chairman of the commission is awaiting Senate confirmation.

OSTP has been closely involved in this issue from its outset. My staff and I helped to establish the Kemeny Commission. Dr. John Deutch, the then Under Secretary of Energy, and I chaired the internal group that developed a response on behalf of the administration. We have been actively involved in the task of assuring the safety of nuclear power, and expect this task to continue.

For over 2 years, OSTP has participated in the President's Interagency Review Group on Nuclear Waste Management (IRG). The particular roles played by OSTP were to chair the technical working group that examined alternative technical strategies for the disposal of high-level radioactive wastes and spent fuel and, in the later phases of the review, to coordinate much of the preparation of the IRG report, the recommendations to the President, and the

subsequent announcements. On February 12, the President sent to the Congress a plan for a comprehensive national radioactive waste management program.

One of the most serious energy/environmental problems that may confront our Nation in the next century derives from the buildup of carbon dioxide in the atmosphere from the burning of fossil fuels and from deforestation.

Plausible projections of future carbon dioxide concentrations suggest a doubling by the middle of the next century. Since carbon dioxide is a powerful absorber of thermal radiation in the region of the spectrum in which the atmosphere is otherwise quite transparent, small changes in the concentration of this trace constituent could have major effects on the heat balance of the Earth. The consequence might be substantial changes in climate and large impacts on society.

This is a problem about which greater knowledge and sophistication are needed. OSTP therefore commissioned two studies by the Climate Research Board of the National Academy of Sciences. The first study examined the status of climate modeling in order to determine the climatic consequences of a doubling of carbon dioxide and the level of uncertainty in our knowledge.

A second study addressed the way in which we might examine and address the potential social and economic impacts of increased carbon dioxide concentrations. My office is currently discussing a further comprehensive review of the carbon dioxide issues as required by the recently enacted synfuels legislation.

NATIONAL SECURITY RESEARCH AND DEVELOPMENT

Our national security depends in large measure on our technological capability, particularly on our ability to meet future challenges by deploying new weapons systems that embody more advanced technology.

Our military investments in new technology over the years have contributed immeasurably to our security.

Now, as other nations are becoming more proficient in science and technology, we must make certain that our research remains at the frontier of knowledge.

For these reasons, an important part of OSTP's activity has been to work with the President; the Office of Management and Budget, and the Department of Defense to restore the declining support for research and technology in defense budgets during the first half of the 1970s.

As a result, the cumulative growth in the technology base from fiscal years 1978–81 will be over 50 percent, including an increase in basic research of nearly 65 percent.

The outside review of basic research in the Department of Defense, which I organized at the request of Harold Brown, was well received by the Department and directly led to the major increases in support for basic research.

DOD also undertook several other actions in agreement with the report's recommendations. For example, the Deputy Under Secretary for Research and Advanced Technology was assigned the responsibility for oversight and management of the entire DOD basic research program.

The Secretary of Defense has issued a policy statement clarifying the Department's view of the role of basic research. DOD is also using some of its real growth in basic research to provide funding to new performers, especially researchers from universities.

As Director of OSTP, I am involved in the development of policy on national security issues. My staff and I chair or sit on various Cabinet and sub-Cabinet level committees and working groups of the National Security Council and participate in the processes established by the Office of Management and Budget for analyzing the defense, intelligence, and foreign assistance budgets.

I have been the chairman of three NSC Policy Review Committee—PRC—groups, formulating the policy options for the China science and technology agreement, reviewing our space policy, and reviewing our telecommunications policy.

At the request of the President, on a number of occasions I have also assembled special committees of prestigious outside scientists and engineers to provide him with independent advice on key national security issues. These have included MX and cruise missile weapons development, the nuclear weapons test program, and arms control issues such as verification procedures for the comprehensive test ban treaty.

INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION

The President's message to the Congress on science and technology spelled out four themes that have shaped U.S. policy in international scientific and technological cooperation: pursuit of new international initiatives to advance our own research and development objectives; development and strengthening of scientific exchanges to bridge political, ideological, and cultural divisions between this country and other countries; formulation of programs and institutional relationships to help developing countries use science and technology beneficially; and cooperation with other nations to manage technologies with global impact. Throughout this administration, OSTP has actively pursued bilateral and multilateral international programs in science and technology in accord with these themes.

In January 1979, the President and Chinese Vice Premier Deng Xiaoping signed an agreement for science and technology cooperation. Since that time, our two countries have signed 13 protocols for bilateral cooperation in a broad array of areas including space, student and scholar exchanges, agriculture, public health, environmental protection, hydropower development, and Earth sciences research. In January of this year, we reviewed, in China, the rapid and remarkable progress that has been made in the implementation of each of these protocols during the first year of normalized relations. At that time we also signed an agreement for cooperation between our two prestigious national academies of science. The S. & T. Agreement provides for facilitation of contacts between the U.S. private sector and the Chinese to support their modernization efforts in energy and other sectors. It is clear that R. & D. cooperation naturally leads to enhanced commercial relationships.

Cooperation with the Soviet Union has changed dramatically as a result of that country's invasion and continued occupation of Afghanistan. The administration has taken steps to demonstrate

that such actions will have an adverse effect on all forms of cooperation, including scientific exchanges. The President has made the deliberate decision to focus our restrictive measures against specific activities, not against the framework of our bilateral agreements themselves. Only those substantive exchanges which are of overriding scientific interest to the United States or which involve humanitarian concerns, such as health or environment, will be continued under the present circumstances.

It is ironic that this change in policy took place at a time when many U.S. participants in U.S.-U.S.S.R. cooperative science programs were beginning to feel that programs of true mutual merit were at last underway. Our decision to keep the framework of cooperation intact reflects this sense of U.S. gain from the programs. At a future time when conditions change, we may want to resume some or all of our cooperative programs with the Soviet Union.

A major step in further expanding the already extensive cooperation between the United States and Japan was the signing of a bilateral agreement for cooperation in energy R. & D. projects, such as coal liquefaction, nuclear fusion, and geothermal and solar energy.

President Carter proposed to the Japanese a complementary program of joint R. & D. in various nonenergy areas of global importance such as space, environmental protection, health, agriculture, and resource conservation. These joint projects are based on the concept of mutual interest and benefit. Manpower, physical resources, and financing of these large-scale projects will be shared. The scale of these programs represents a new concept in international S. & T. cooperation.

Impressive progress has been made in our science and technology relationship with Mexico. During the President's February 1979 meeting with President Lopez Portillo, our two countries signed a memorandum of understanding to inaugurate cooperation in a number of areas including arid lands agriculture and energy R. & D. In October 1979, I led a delegation of senior Government scientists and science officials to a number of countries in South America and the Caribbean, including Venezuela, Brazil, and Peru. We also met with representatives of the Andean Pact and Caribbean regional organizations. As a result of consultations with leaders of these areas, numerous joint S. & T. activities are underway and many additional ones are planned.

Tomorrow, I will lead a high-level scientific delegation to Africa where we will explore with Nigeria, Zimbabwe, Senegal, and Kenya, the potential for various kinds and levels of scientific and technological cooperation. We believe that the respect for our science and technology can be a firm and stable strand in the constantly shifting web of relationships with the Third World.

As you know, Mr. Chairman, we have tried to establish the Institute for Scientific and Technological Cooperation. Although this has been authorized by Congress, we have not been successful in procuring an appropriation. We will continue to try to achieve this. This has brought home the continuing need for an expanded role for science and technology in our relationships with the developing world.

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SPACE POLICY

The U.S. space program has made dramatic progress since its inception almost a quarter century ago. Now our national space program is entering a new stage of maturity—one in which we will receive increased dividends through scientific exploration and technological applications.

The Carter administration's space policy is designed to carry us successfully into the next era in space. We have for the first time the opportunity for choices with regard to direction and pace. First, our space policy will reflect a balanced strategy of space applications, space science and exploration, and technology development. Second, our space policy will become more evolutionary, rather than centering around a single engineering feat. Our space policy is sound, progressive, and fiscally responsible—very appropriate for this pre-Shuttle period.

Completion of the Shuttle is our highest priority. The Shuttle will be central to our national efforts in space science, commercial space utilization, defense, and technological leadership. In addition, its completion could release significant funds for new space science and applications projects—a matter of some concern to members of the space science community who fear the demise of planetary exploration and space research.

Despite budgetary constraints, our space science and exploration programs continue to be challenging. We have exciting missions now underway. The Voyager craft, having explored Jupiter, will continue on to Saturn and then Uranus. Under development are Galileo, which will explore Jupiter, the solar polar mission, several Explorer missions, the space telescope, and of course Spacelab. Work on the new gamma ray observatory will start next year. In addition, we are considering two new programs—the Venus orbiting imaging radar and a Halley Comet mission.

II. THE DECADE AHEAD

Mr. Chairman, I wish to conclude my statement this morning with a very brief look ahead. As we enter the decade of the 1980's, we are devoting increasing attention to future trends in science and technology and their impact on domestic and international affairs.

In this regard, the 5-year outlook is particularly valuable. The outlook itself, together with the supporting source materials, provides a 5-year perspective on several broad policy areas as well as concise syntheses on eight specific topics—energy, materials, transportation, space, agriculture, health, electronics, and risk assessment. I have spent many hours looking at the new 5-year outlook.

As I look toward the future, I visualize not a deemphasis on technology, as some would have it, but rather an increasing focus on the appropriate and responsible development and application of technology to meet domestic and international needs.

For example, as it becomes ever clearer that a major cause of inflation is weakness and sluggishness on the supply side of the economy and that our competitiveness internationally depends upon increased industrial productivity, more and more attention will be given to revitalization of our industrial sector. Science and

technology will play a major role in solving many of the complex problems confronting existing industries and in making the transition to many new industries for which we are, and have been, laying an R. & D. base, for example, biotechnology and automated tools.

Related to this emphasis on industrial innovation and productivity will be further rationalization of the regulatory process. Although protection of human health and safety will remain paramount, increased attention will be given to assuring that regulatory decisions are based on the best possible science and that the resulting regulations are implemented in such a way as to minimize the adverse impacts on industrial innovation and productivity.

Perhaps nowhere are the expectations of science and technology as high as they are in energy. As the Nation struggles to decrease its dependence on foreign energy sources and the economic, social, and environmental costs of proposed alternatives become clearer, technology is increasingly looked to for answers. Even more sophisticated means of locating energy resources, introduction of the next generation of current energy technologies and development of alternate technologies for central and local power generation will characterize the 1980's and 1990's.

In terms of the conduct of research and development, this decade will see constructive changes in the relationships among the major performing institutions. More and more, the national interest will be served by cooperation among Government, universities, and industry. University-industry linkages will help stabilize university science programs and stimulate innovation. Joint government-industry research programs, such as CARP, will focus the country's best research talent on generic research problems not otherwise being adequately addressed.

The Government and academia will continue to explore new institutional relationships which maximize the performance of research and minimize the intrusion of Federal rules, regulations, and procedures. The enhanced support we are providing will lead to major scientific discoveries.

Internationally, science and technology will be a key factor in maintaining our national security and our standing in the world. Our relations with the Third World will take on a new dimension as we increasingly focus on direct technical assistance as the major element in our bilateral aid programs.

Mr. Chairman, I believe that the next five decades will test both the Nation and the world in a way that neither has been challenged before. Domestically, our most important problem may be one of governance; the complexity of our Government at all levels, the rise of special interests, the compartmentalization of Government, and polarization of our people contribute to our inability effectively to move forward toward consensus on many fronts.

We face even more difficult problems internationally. At a time when we should be expanding our commitments to international activity, especially through the support of scientific and technical assistance to the developing nations, many would cut these funds still further. The Global 2000 report to the President catalogs many of the seemingly overwhelming problems facing mankind world-

wide: abject hunger of over 1 billion people; the economic, social, and environmental consequences of expanded worldwide energy consumption; deforestation; reduction of genetic stock; declining agricultural productivity; continued population growth; and numerous other fundamental problems that must be dealt with responsibly.

Arms limitation and control remain a primary concern. Effective use of resources, including ocean resources, will also be a critical test for all nations.

There are some deleterious effects of technology, of course, that must be addressed. But overall, I remain optimistic that these can be controlled. Science and technology will yield unanticipated positive results that will contribute substantially to the resolution of global issues. In this century we have witnessed a number of such advances that have profoundly affected agriculture, communications, and transportation. Our task in the 1980's is to insure that our national commitment to science and technology remains vigorous so that these unanticipated but profound, beneficial advances continue to take place.

Mr. Chairman, this concludes my formal statement. My colleagues and I would be pleased to answer your questions.

Senator STEVENSON. Thank you, sir. That is a fine statement.

As I indicated to you earlier, I think you have done an extraordinarily good job in your difficult office. Your responsibilities range virtually the entire panorama of subjects of public policymaking, and across that range I think you have given some very sound thought to scientific and technological considerations. I think you have established in the main a sensible set of priorities, and with limited resources and at times, I know, with limited support in the administration.

Dr. Press, you began with, among other things, consideration of the budget. I know you have supported consistent real increases in Federal support for R. & D., including basic research; and that the President has on a number of occasions expressed a similar commitment. But I don't find that commitment reflected in the figures. And grant you, we have had so many budgets and so many economic proposals in short succession that it is a little hard to follow all of these figures.

The President's most recent economic proposal included support for increased Federal R. & D. of about $300 million in fiscal year 1981, and in fiscal year 1982. But if I am correct, that recommendation of a $300 million increase for each of these years follows a decrease of $900 million in the revised fiscal year 1981 budget. He is only restoring a part of an earlier cut.

And the figures that our counsel gave me indicate that the revised 1981 budget contemplated in constant dollars a commitment of $2.4 billion in fiscal year 1979, $2.4 billion in fiscal year 1980—that was the revised figure—and $2.4 billion in fiscal year 1981 for basic research. These are constant dollars. There is no increase for basic research. And now, in this latest economic proposal, we are only getting a partial restoration of the cut in overall Federal support for R. & D. that the President proposed in the revised 1981 budget.

Dr. PRESS. Let me respond to that. The new funding in the President's economic message will permit an increase in the support of basic research over the 4-year budget period which this administration has been in office of 11 percent growth above inflation. Of course have to project both the 1981 and the 1982 inflation rates, using OMB's estimates.

More specifically, the added funds for 1981 in the supplement we will be requesting permits 3 percent real growth above inflation for 1981. We are making the commitment now to have 3 percent real growth above inflation for 1982. When added to the real growth in the past—chiefly between fiscal year 1978 and fiscal year 1979—we have an impressive overall record.

Perhaps the confusion is you are talking about R. & D. rather than basic research.

Senator STEVENSON. The figures I read to you a moment ago are from the AAAS report. It shows $2.4 billion for each of the fiscal years 1979, 1980, and 1981. The $2.4 billion for 1981 is from the revised budget. And the most recent program of the President does indicate the $300 million overall increase.

Dr. PRESS. That's the point. We dropped the budget for basic research by $190 million in the March reassessment. We now have $300 million additionally.

Senator STEVENSON. That's not all basic research. Where does that go?

Dr. PRESS. The first will be to honor the commitment of 3 percent real growth above inflation for 1981. We can do that and still have some $75 to $100 million left over for use in other programs, such as encouraging industry-university cooperation, a program for revitalizing obsolescent facilities, and even some other possibilities.

Senator STEVENSON. We have to take a closer look at these figures. But I think it would take a mathematical magician to produce from $2.4 billion, $2.4 billion, $2.4 billion, a real increase of 11 percent over those 4 years in basic research.

Senator SCHMITT. After this vote I may have to stay over at the Appropriations Committee on the continuing resolution, and I want to thank Dr. Press for his statement. My concerns are directed more at the administration rather than at you, Frank. I think you have tried to put the best face on what I do not think is a good record in science and technology by this administration.

Maybe we made some progress, but we have to say that it is in spite of the administration rather than because of it. You have outlined many of the issues that still face the country and did face us 4 years ago. You left out some. One very critical one is strategic minerals policy. We are 65 percent dependent on import of strategic minerals and only 45 percent on crude oil. And both are unacceptable.

Most of the areas where you have indicated the administration has a policy, of course, I would not say they have a policy worth the name. Maybe my greatest concern is that there seems to be a contempt for the legislative process on the part of the administration. In areas where the Congress or Members of the Congress, including members of this committee, have proposed policy initiatives, we have generally been opposed. And where we have opposed

the administration on an issue, such as the CARP program, there have been strong attempts to end-run the congressional process.

I am very much concerned about the status of science and technology policy in this country, not the least part of which is science and technology education.

I think we better recess for about 10 minutes while the chairman and I go vote.

[Recess.]

Senator STEVENSON. The subcommittee will come to order. I am sorry about the interruption, Dr. Press.

As part of its domestic policy review on industrial innovation, the administration promised an antitrust guide for firms interested in conducting cooperative R. & D. What is the status of that guide?

Dr. PRESS. The Department of Justice is working on that. It is being reviewed by a group of both technical experts and antitrust lawyers. We expect the statement, the policy statement, to be issued by the Department of Justice this fall.

Senator STEVENSON. How is the antitrust problem resolved in the CARP program?

Dr. PRESS. The basic issue is the degree to which firms in the industrial sector can cooperate. The notion that my office is trying to put forward, is that in the area of basic research, where the commercial product is not visible in the near-term, where the basic research can help an entire industry, then cooperation within a sector is an important thing to do to help the whole of the industry. It would not impede competition, and such cooperation should be allowed. It certainly is allowed in all of our western industrial competitors abroad.

We are not sure that it ever was disallowed in the United States. But the perception in industry was that they had better not do it. So we sought a clarification from the Department of Justice and our discussions with the antitrust people have been positive. We expect to have a good resolution of this.

Senator STEVENSON. It hasn't yet been resolved for the CARP program, for which funding is now being requested.

Dr. PRESS. For that specific program, it has been resolved. The Justice Department reviewed the CARP program and wrote a business review letter which gave permission to go ahead.

Senator STEVENSON. What is the status of this same issue with regard to ocean margin drilling?

Dr. PRESS. The same situation exists for the ocean margin drilling program. The Department of Justice issued a business review letter which—which essentially gives us the DOJ consent for this program to go forward.

Senator STEVENSON. I don't want to dwell on this. Maybe we can get a copy of that. I think we do have a copy of the one in connection with CARP. And I mentioned that because we are running up against antitrust considerations in virtually every effort to develop cooperative responses within the United States to critical economic problems. It came up in conjunction with our trading company legislation recently.

It comes up in conjunction with industrial innovation. And as you point out or imply, these antitrust laws in the name of competition are preventing, frequently, the United States from effectively

competing with not only Western, but even more obviously, Eastern foreign competitors. I therefore think that it has got to be resolved. It cannot be resolved satisfactorily by the administration alone.

There is nothing that business review letters can do, for example, to protect the participants in a cooperative research effort from civil antitrust—from private sector antitrust suits. And only to a limited extent does it give the parties the kind of protection that they seek, protection from Government antitrust litigation.

Now, we wrestled with this problem in conjunction with the Technology Innovation Act, which has passed the Senate and has passed the House. This is one of the issues again that we are facing. Our approach to it was worked out with the Commerce Department. Since then, the administration has backed off.

That is what we are attempting to do in this industrial innovation, this technology innovation legislation. I am not convinced that you can do it administratively. In any event, we are going to have a model for industrial cooperation on research projects, generic research, through what we call innovation centers and with the sanction of law, and I believe with the procedure in the law that provides for business reviews opinions. And this model is very consistent with what the administration proposed as a result of its DPR. And as a matter of fact, it is already being implemented through programs of the NSF and now the Commerce Department.

I think just a few days ago, Commerce announced three such proposals. If you have that model on the one hand for industrial corporations generic research, supported by the administration and by the Congress, why wouldn't that be the model for automotive research?

If it is good for industry generally, why not for automotive research? And incidentally, why should it be confined just to automotive, if, as the Department of Transportation witnesses recognize, there is synergism between different competing modes of transportation, and indeed they didn't want to confine it to automotive research?

Dr. PRESS. The two approaches are not mutually exclusive. Each industrial sector has to be examined for the optimal solution if there is a problem. The industrial sectors are so different that in one case one approach might apply and in another case the generic technology centers might apply.

In the area of cooperative automotive research, we were impressed at how little, for example, the university engineering schools across the country were involved in automotive research. It is one of the few major industrial sectors where this vast and intelligent community was relatively little involved. So one motivation in pursuing the mechanism we designed was to bring new research performers into the basic research areas dealing with automotive technology.

That perhaps can be the most important contribution the CARP program would be making. Beyond that the kind of research we had in mind had such a broad diversity dealing with new materials, energy storage devices, aerodynamic design, the nature of the internal combustion process, we thought that a diversified approach where there were different centers, different university lab-

oratories, for example, concentrating in each of these would be more effective than setting up a single generic technology center dealing with the automotive industry.

In some cases the program you have proposed would be effective and in other cases we feel that the kind of approach that we have come up with is more suited to a particular industry.

Senator STEVENSON. I am sorry if I misled you, but our approach does not contemplate one big center for automotive technology. First of all, we are suggesting that all of the generic subjects for research that you have mentioned have applications outside of automobile technology. The innovations centers that the legislation and the aministration contemplate wouldn't necessarily lead to everything at one center. On the contrary, I think the use of that model would lead to decentralization with research on materials, lubricants, drive trains, the fluid dynamics, and so on. All that you mentioned and a good many more subjects would be dispersed to appropriate institutions. That is what is contemplated, and that is what has been recommended by many of those that we have heard from in the universities, some of whom are conducting automotive research and complain to us that their problem is the unwillingness of the automobile industry to accept their research.

That is beginning to change. One of the specific complaints that we get here is that it is always the Japanese and the Europeans who are most willing to accept the benefits of university research, with some very specific examples involving fluid dynamics—Peugeot and one of the Japanese manufacturers. That is going to be a problem no matter how you go. But I think you exaggerate the problem, based again on what we hear, this time from the automobile industry, by putting it in what they regard as a hostile agency, a regulatory agency, DOT, instead of under other agencies that they regard with more confidence than the Department of Transportation.

Dr. PRESS. Let me point out some other things, Senator. When we brought the auto industry executives together for the first time in my office, they weren't sure that it was legal to do so. It was the first time they had all met together in the same room legally. The notion that they could work together as a group in basic research on behalf of their own industry, was a new one for them. And yet this program accomplished that. The negotiations with the Department of Justice to get approval for this program were unprecedented, yet this cooperative program accomplished that.

The public perception that there was an adversarial relationship between the auto industry and the Government was common throughout the country, and yet this program showed that Government and the industry can work together to design an overall plan, to meet periodically to review the plan.

The issues of patent policy and how the companies participating would be affected had to be worked out. It had never been addressed before. We worked through that. It was a prolonged negotiation which had valuable institutional results, in addition to the important research results that will flow from this program. So this institutional mechanism that we have created will have fallout, I am sure, in the antitrust area, and the notion of cooperation between companies in a given sector, and the image of people

throughout the country that Government and industry can work together. Take that into account in contrasting these two approaches.

That is why I say particular industrial sectors have to be examined as to which is the best approach. In many cases the approach that you have brought into being through your legislation will be the ones that we will follow.

But I believe the auto industry and its problems are best served by the manner in which we are proceeding.

Senator STEVENSON. My own opinion is that all of those objectives could be better achieved by different institutional arrangements and that, in fact, everything you have suggested has not been achieved, including the active cooperation and participation of General Motors. I don't think, for example, that you really know what is being done in-house, in these corporations, and without knowing what kind of generic technology that is now being researched, that is now being conducted, or that they are capable of conducting, or are willing to conduct in the future, you are not in a very strong position to decide what should be done cooperatively out of house.

That is not all your fault. It is partly owing to the attitudes in this unique industry which generate an awful lot of secrecy and suspicion, especially toward Government. We are getting more information about research in the foreign manufacturers than we get from our own.

Now while we are still on the subject of cooperation, what is your view of the alleged crisis in Government-university relations? You are familiar with the complaints of Dr. Wiesner, among others. Those complaints in the past, were focused on the A-21 cost accounting procedures. What is your opinion of the relationship now between Government and the university?

Dr. PRESS. I had a meeting last Tuesday between the Vice President and some 20 university presidents. Anyone attending that meeting would not conclude that there was a crisis. In fact, the meeting was a laudatory meeting on the part of the university people in terms of the administration, with the administration's strong support of the universities—not only rhetoric, but in terms of the budget, our concern with stability and financing, and with the problems that they face.

There was a particular issue that you refer to, the so-called A-21 issue. That regulation requires certain steps to be taken in the area of accountability for funding of Federal research programs. The regulation came forward after several years of negotiation, discussions and multiple iterations with the university community. A number of universities have already implemented these regulations without complaints and without any problems.

Several prominent schools do have some difficulties, particularly in the area of effort reporting. That is the reporting of individual faculty members as to how he spends his time.

I have encouraged OMB to enter into discussions with the universities concerned to see if some experimental programs might be launched or other ways of handling this particular regulation. We have considered some statistical form of reporting rather than requiring each faculty member to make these effort reports.

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OMB has committed itself to investigate and implement this approach, and the letters have gone out to the universities inviting this kind of experiment, to make it easier for those universities with problems, particularly, to participate.

We do have our responsibilities in terms of assuring accountability in the expenditure of Federal funds. We are trying to meet them in a way that has least impact on the universities. And where a major disagreement or problem arises, as we have just been talking about, we do enter into a serious negotiation to see if we can resolve that difficulty and still meet the Government's responsibilities.

Senator STEVENSON. That is encouraging, and you will keep the pressure on.

I'm going to jump ahead to my questions on space policy. I think I mentioned earlier that I have had some disappointments, as well as some pleasant experiences. The area of space policy has been disappointing, and I say that not because there hasn't been enormous progress, but because of the tremendous potentials of space technology that are not being recognized, certainly not by the American public, and they are not being reflected in American policy. And here again the competition is threatening.

What can be done to develop a space policy for the Shuttle era that establishes some objectives and a far more systematic method for reaching them than our present method, which is—as we all know, is ad hoc. It is off the seat of our pants, and it is from one budget cycle to the next. The NASA budget has been savaged this year. The space sciences, new starts, the civil side, placed aside.

I also see the the black side with another hat. That side doesn't pay the price. Ultimately the failure to move on the civil side may have more adverse implications for our national security, I think.

I can't remember now exactly what you said. You addressed the subject of space. What more is being done to really formulate an American civil space policy for the Shuttle era than has been done so far or is being done?

Dr. PRESS. Let me begin by saying I spend more time in Congress trying to defend the space budget against cuts of the administration's proposed budget than on any other important issue. So it is a problem; we can be hit here because we are not doing enough and then we walk down the hall and try to defend our budget from cuts. It's very difficult.

Senator STEVENSON. If I can interrupt, I accept the validity of your complaint, and when Senator Schmitt and I complain about inadequate Federal support for R. & D., don't be too defensive. The Congress deserves the criticism too. Perhaps even more so. But that is one of the reasons why we have both suggested a space policy. If there was a space policy, one approved by the Congress, which did establish long-term objectives and some intermediate objectives like a civil remote, operational remote sensing system, then you would be in a much stronger position here in the Congress. And then the Congress would be in the position of having to fulfill its own commitments in space, instead of now as it is, with one budget after another, very little discretionary spending, none of it in the military sector which has to keep going up. And in the end Mem-

bers of Congress looking around to find some vulnerable discretionary function like 250, which they end up savaging.

I think the only way to get around that problem is by making that function a little less discretionary. And you do that, or one way you do it is by establishing some long-term objectives in space.

Dr. PRESS. I really can't agree that we have no space policy, that we have no long-term objectives. You and I have discussed this before. Our objectives were discussed in my testimony, although I cut them back in the verbal presentation. The science and technology message of the President included a discussion of his goals in terms of space policy.

As you know, we have a commitment to the Shuttle, supplying all of the funds necessary to bring to flight-readiness the Shuttle transportation system, and it would be unmatched by any other country for the remainder of this century. It's capabilities will be enormous, not simply the system we have now, but also extensions to the system that will shortly come onstream. We have a commitment to a strong leadership space science program. We have two new starts this year, despite a tight budgetary situation.

And as the runout costs of the Shuttle become available for other purposes, we can even strengthen our space science program even further. We think that the time for applications for the use of space for the good of humanity, for the good of industry and commerce, has arrived. We want to reap some of the dividends of our enormous investment in space, and we are planning to do that in a number of different ways.

There may be a policy difference between you and the administration as to how much we should do, but we do feel that we have a program for space. What we are worried about is a premature policy commitment to a loose program leading to manned-space flight to other planets and the colonization of space and the resulting budgetary impacts of the order of hundreds of billions of dollars.

That is not what we are seeking at this time.

We have secured a commitment that you have been interested in for years to an operating space remote sensing system for the civil sector, and guaranteed continuity of data in the operating sense. We have converted the program from an R. & D. program, which it has been for the last 10 or more years, to an operating program. That is an important contribution.

Senator STEVENSON. That is also a slight overstatement.

Dr. PRESS. In what way?

Senator STEVENSON. That we have now an operational remote sensing system? In a sense it has always been operational. There hasn't been a significant change except for some organizational change. We have been pushing and holding hearings. In fact, I thought we had an agreement to fund the first stage of an operational remote sensing system. But we can't go through with it now because it is not there.

Dr. PRESS. I say we made a commitment to an operating system. The Government is now committed to having an operating remote sensing system, whereas in the past all we guaranteed was the R. & D. targeted on a remote sensing system, with uncertainty as to whether we would ever go to an operational phase. We have

now made that commitment to continue in remote sensing with an operating system, without defining what those systems will be. We will let technology pace that decision.

Senator STEVENSON. Have you or to the best of your knowledge have any others in the administration considered the possibility of developing international peacekeeping efforts in space, using space technologies for monitoring and verification purposes as they are rendered obsolete by new technologies?

I say that because the opposition in the past by the United States to such an effort has been based on the danger of compromising national means of verification. But you know, I think—and it is certainly acknowledged widely but privately within—among those, you know, that technologies with strong capabilities for Earth observations as well as for monitoring could be put into place in a few years without having any such adverse effect on national means of verification.

And yet, while Dr. Teller and President Giscard and many others around the world support the general concept, the United States and the U.S.S.R. do not, the U.S.S.R. for reasons which are more obvious to me than those which continue to lead the United States, maybe not to oppose any more, but not to support such an effort; the purpose, of course, being to subject military activities of all nations to observation by all others. And there is some expectation that kind of observation may be a more effective deterrent to misbehavior than the observation by one superpower of the other.

Dr. PRESS. The goal is certainly a laudable one. The notion that we can use this technology on behalf of peace is an extremely significant statement that high technology can be used for the good of humanity. And one has to support this as an ultimate goal. As to when we are ready as a country, when other countries would be ready to undertake this kind of an effort, that is a matter of timing. That is a matter of understanding of the views of the many different countries beyond the Soviet Union and the United States, many countries which would resent the open publication of photographs from satellites of their own countries.

Senator STEVENSON. Including the Soviet Union. Are we going to wait for them?

Dr. PRESS. Many neutral countries would resent it. Even though they know it is going on, they would resent the open publication. It would have to be worked out diplomatically. It would be tedious. As I said with the opening of my remarks on this question, the goal is a laudable and an important one, and I hope that eventually we do achieve it.

Senator STEVENSON. That's all it is. We are waiting. I have met with the representatives of more of those countries than the State Department has. I think the State Department would find widespread support and lots of possibilities for overcoming the anxieties which you mentioned. And the very fact that they could not be overcome in the Soviet Union is one of the reasons I propose it for a country which has always ostensibly been committed to open skies and onsite inspection.

Dr. PRESS. I hope you will urge your approach.

Senator STEVENSON. I urge you to push on that, too. I am not going to be around here much longer and I hope you are.

Which brings me to the next subject: the 5-year outlook. Do you still think that the president of the Academy of Sciences is the best person to prepare that outlook?

Dr. PRESS. The first product of the Academy is being very well received. I have heard nothing but favorable comments, although I haven't heard your views yet. But wherever I travel——

Senator STEVENSON. I agree. I think it is very well done, with some reservations.

Dr. PRESS. Dr. Gomory is here and he deserves a great vote of thanks from all of us for doing so fine a job. I have met with the group at the Academy that is doing the next report. There are several Nobel Prize winners working on this. Several of the country's most innovative industrial leaders are involved in the Academy's next effort. As the next version, which should be out in a year or so, it should be equally good. If there is any weakness in the first version, it is in the Government overview on the Academy report. That can be strengthened. We are learning how to do these things better and better.

This also holds with the annual reports that have been sent to Congress. So as we learn how to do these things better, I think the product will improve. But the basic notion of having the Academy gather together the leaders of science and technology in the country and to say to them: How do you think the next 5 years will be, what are the opportunities for technology in this period, what are the problems that technology would pose to us?—and then have the Government policymakers take this and develop it into some policy objectives—I think that technique, which evolved in your office, as you know, Senator Stevenson, is a good mechanism. It is a good way to do things. And we will improve the Government effort.

Senator STEVENSON. How could that last step, namely the preparation of the Government overview, be best accomplished?

Dr. PRESS. We are taking a number of steps, both with the 5-year report and the annual report, to improve that. As you know, the National Science Foundation is responsible for pulling this together. We have now established linkages between the NSF people and individuals in my own office, person-to-person linkages in major areas of technology. We have also used the Federal Coordinating Council, which I chair, to have input in an integrated way, rather than simply an agency-by-agency way, into the analysis of the raw materials for these two reports. So we are sensitive to the weaknesses of the past and we are trying to improve that situation.

Senator STEVENSON. Should the responsibility for preparation of that overview be in your office?

Dr. PRESS. The things I have described to you which my office has arranged show that we care about having this product represent the administration view on these problems. I think that has happened.

Senator STEVENSON. It has happened. But as I understand it, the responsibility is in NSF, isn't it?

Dr. PRESS. This goes back to discussions we have had before, that if you want my office to do the many things I described in my testimony, then I could not also take on this additional task. All of the things that I described to you I think have higher priority.

Senator STEVENSON. As I indicated, I know you are overworked.

Dr. PRESS. We are trying to use a much larger staff with the Foundation and the other agencies to help us move this thing forward. We are not cutting ourselves off from these reports. We are trying to orchestrate them and have the work done by the agencies with the much larger resources.

Senator STEVENSON. Our response to that is we are really not asking you to prepare the whole report. It is just the overview, with the suggestion that your office is a more appropriate office for expressing government policy than the NSF, and it really shouldn't take an awful lot of resources in your office to in effect express what the policies are.

Dr. PRESS. I am hoping you are not implying that our office is secretive and doesn't communicate. I have discussed policy in my congressional testimony, in the science and technology message, and in my many personal discussions in the offices of Congressmen and Senators. I think I have spent more time on this than all of my predecessors combined.

Senator STEVENSON. You are protesting too much. I was not suggesting that.

Dr. PRESS. Excuse me.

Senator STEVENSON. I don't think it would be too hard to prepare that overview in your office. And it is more appropriate there than in NSF, because this is where responsibility for science and technology is proposed.

I wasn't intending to be critical, Dr. Press. I think you have done an extraordinary job, and your colleagues. And we are all trying to help up here, although there is something inherent in our society that always gravitates, whether it is between Government and universities or between labor and management—we were suggesting a moment ago, even between companies—toward combat instead of cooperation. We have an instinct for creating adversarial relationships where there shouldn't be, and sometimes for appearances that belie the reality.

I think in this case it has all along been a very cooperative relationship between this subcommittee and your office. It certainly has been a very satisfactory relationship from my standpoint and our staff's. And I regret it is coming to an end. But perhaps it will continue in another world. I hope so.

Dr. PRESS. I hope so. I have learned a great deal from my personal relationship from you, and the advice you have given to me on numerous occasions about how to get things done in Congress, how to have better communications. And also your early ideas on technological innovation. I think that is perhaps the most important issue for the decade for our country. You have taken a leadership role——

Senator STEVENSON. Now you are beginning to sound like a Senator.

Thank you. Your many virtues include charity.

Thank you very much, gentlemen.

Dr. PRESS. Thank you.

[The statement follows:]

STATEMENT OF DR. FRANK PRESS, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Mr. Chairman, I wish to begin by stating for the record my admiration for the wisdom and leadership you have brought to this Committee during your distinguished tenure as Chairman. I think you can be proud of the impact you have had on Federal science, technology, and space programs and policies over this period of time.

Over the past 3½ years, I have endeavored to institutionalize the Office of Science and Technology Policy (OSTP) as an Office capable of fulfilling Congressional expectations while meeting the science and technology advisory needs of the President and his Executive Office. Throughout, I have felt that we were partners in this enterprise. I see such a partnership as vital to the success of OSTP and to the strength of the Federal leadership in research and development. For this reason, we have made every effort to cooperate with this Committee and with other committees concerned with specific scientific and technological issues. In addition to our regular appearances before the oversight committees, we have had private consultations with the Chairman and with other committee members and have testified often on specific issues when it was felt that our particular policy perspective might prove useful. As appropriate, we have worked with this Committee and with others on the development legislation of mutual interest; examples include the climate bill and the recently passed aquaculture bill. Finally, the Science and Technology Message of the President, transmitted to the Congress in March of 1979, described the Administration's science and technology policy perspective, highlighted specific initiatives, addressed potential future impacts of scientific and technological advances, and provided a policy framework for Congressional consideration of Federal research and development programs as recommended in the President's budget.

In my testimony today, I would like to present to this Committee my perspective on the activities and accomplishments of OSTP during my 3½ years as its Director and to take a brief look at emerging issues of the 80s.

I have with me today my three Associate Directors, Benjamin Huberman, Denis Prager, and Philip Smith, and the OSTP Executive Officer, William Montgomery. They will join me in responding to your questions.

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My discussions in early 1977 with the President and Vice President led to a broad outline of Administration policies emphasizing growth in the support of basic research, an increased role for science and technology in regulatory decision-making, incentives for technological innovation, and an enhanced role for science and technology in international relations. Extensive conversations with representatives from the academic and industrial sectors helped to indicate the scope and magnitude of the problems faced by these sectors, and to clarify and refine the specific issues within the broader policy areas.

The high priority policy issues emerging from this process formed a working agenda for longer-range policy analyses initiated by OSTP and provided a context within which issues brought to the Office could be analyzed. This policy framework, the personal and organizational relationships formed with colleagues in the agencies, the Executive Office of the President, and the Congress, and a wide-ranging network of formal and informal consultants from many disciplines and institutions, have permitted our small but expert staff to accomplish a great deal in a relatively short time.

Strengthening U.S. science and technology

Underlying this Administration's science and technology policies and initiatives has been a consistent and intense concern for the strength of the scientific and technological enterprise in this country. My early consultations with government research and development managers and academic and industrial leaders helped identify the key factors which have formed the basis of our strategy for strengthening U.S. science and technology: A stable, balanced Federal R&D budget; enhanced government support of basic research, strengthening of research and development programs within the mission agencies; better cooperation among and within the university, industry, and government sectors; support for modernization of university research and development facilities and equipment; attention to science and engineering manpower needs.

President Carter's R&D budgets have helped compensate for a previous decade of declining Federal support of R&D. Including the Revised fiscal year 1981 President's Budget, the Administration has proposed approximately 35 percent growth in the support of both R&D and basic research over the last 3 years. This philosophy of

support for research as an investment in the Nation's future was reaffirmed on August 27 when President Carter announced his "Economic Program for the Eighties". An integral part of this Program is an expansion by $600 million of Federal support for scientific research and development over the next two years. A substantial portion of these funds will go toward increasing the budget authority in the fiscal year 1981 and fiscal year 1982 budgets to assure 3 percent real growth in Federal spending for basic research.

Continued fiscal commitment to Federal conduct and support of R&D reflects not only the President's personal convictions, but the important role OSTP now plays in the budget process. Throughout the year, we work with our colleagues in the Federal research and mission agencies to strengthen their R&D programs and help shape their budget requests. We have established excellent working relationships at all levels of OMB and are an integral part of the OMB budget review process, from the detailed budget examiner analyses through the final decisions by the President. In addition, we attempt to follow the President's budget through the congressional authorization and appropriations cycles, promoting and defending key R&D provisions as necessary. Although this is a time-consuming and sometimes arduous activity, the importance of the budget in shaping and implementing R&D policy—and the significant growth in the Administration R&D budgets to date—justify our efforts.

One of the things we are trying to do, related to the R&D budgeting process, is to bring more stability to the research community by longer term research planning, and by negotiating a base of support that good researchers can depend on. As we all know, nature does not yield her secrets on the basis of the annual budget cycle. Therefore, there must be more continuity of support to hold together high quality research teams and permit them to carry out important long-term scientific investigations.

The budgetary, authorization, and appropriations process has reached a level of complexity that causes many in the Executive Branch and the Congress to question its efficiency and to seek ways to improve the process. The concept of multi-year projections of budgets for research and development and then authorization, is drawing increased interest. We support Congressman Don Fuqua, Chairman of the House Committee on Science and Technology, in his proposed legislative effort to achieve an effective multi-year authorization process. I think it is fair to say that neither we nor Mr. Fuqua expected to reach mutual agreement so quickly, or that there would be such enthusiastic support by others. The passage of the multi-year authorization legislation by the Senate this year would have Administration support. If we can facilitate enactment of the bill originating in the House, we wish to do so.

Let me turn now to some non-budgetary matters.

Early in the Administration, we initiated studies of the state of basic research in the mission agencies. We took measures to upgrade research in defense, energy, and agriculture. We have had success in all three areas—creating, and subsequently strengthening, a strong Office of Energy Research in the new Department of Energy, a Science and Education Administration in the Department of Agriculture, a program of basic research related to automotive technology in the Department of Transportation, and a new focus on basic research in the Department of Defense.

Similar benefits could accrue from a better university connection with other agencies and other sectors of our society. We have been working for this, directly and indirectly, through such mechanisms as competitive grants in agriculture and through university-centered environmental research centers established by EPA.

Non-fiscal resources must also be considered as major factors in the strength of the U.S. scientific and technological enterprise. These include equipment, facilities, and manpower. As Director of OSTP, I have been made increasingly aware of the steady decline in the quality of scientific instrumentation and facilities for research and teaching within our research universities and engineering colleges.

Over the last three years we have worked with Federal agencies to identify ways to somewhat alleviate this problem consistent with current budget realities. For example, NIH and NSF have received some additional resources in the President's budgets for upgrading research equipment. In addition, they have explored ways to encourage time-and cost-sharing of valuable scientific resources. The President's economic program proposes the initiation of what we expect to be a long-term emphasis on upgrading university science and engineering facilities.

Another critical resource is, of course, scientific and engineering manpower. Because of the rapidly changing needs for various scientific disciplines and engineering specialities and of the lag-times inherent in the education process, predicting demand and influencing supply of manpower has proven particularly difficult. For this reason, the President commissioned a study by the Department of Education

and the NSF to assess the current and projected supply and demand of science and engineering personnel and to assess the quality and appropriateness of science and engineering education.

It seems increasingly clear that the strength of the U.S. scientific and technological enterprise depends upon close cooperation among the three major R&D performers—government, industry, and universities. Bringing about such cooperation is a real challenge because of the diversity among these sectors. Yet, the potential benefits of increased cooperation among these three sectors in research and development justify the considerable OSTP efforts in this area.

Partnership with American industry

Industrial innovation.—A dominant theme of the meetings I held with industry executives during my first few months as Director of OSTP was the impact of government policies on industrial innovation. The leaders argued for a major government program of actions designed to increase industrial innovation by providing specific incentive and by removing specific disincentives. These conversations led me to recommend to the President that he initiate an examination of government actions to enhance innovation. While there had been previous studies of innovation, these had not engaged Cabinet heads and the President.

The resulting Domestic Policy Review on Innovation, with which you are most familiar, recommended that the President take a number of steps to stimulate innovation. The President's decisions were announced in a message to Congress, delivered in October 1979.

These initiatives included:

Expansion of government efforts to transfer to industry—particularly to small firms and business—technological know-how generated through government-supported R&D.

Increased government research and development for technologies of special value to industry, including R&D on generic technologies such as that supported by the Department of Commerce.

Enhancement of the NSF programs which foster industry-university cooperative projects and provide funding to small companies for development of venture analyses of new products and for demonstration of technical feasibility.

Strengthening of the patent system.

Clarification of anti-trust policy to allow companies in a given sector to cooperate in basic research.

Establishment of State and regional Corporations for Industrial Development (CIDS).

The incorporation of a number of these initiatives into the legislation you have sponsored, Mr. Chairman, will help ensure that they go forward effectively.

We realized when the President's innovation initiatives were announced that, from industry's point of view, the most important area affecting industrial innovation was economic policy, particularly Federal tax policy. When the innovation proposals were released, a commitment was made to consider tax incentives for innovation and productivity, as part of future tax proposals.

The economic program announced by the President on August 27 takes the next steps in government efforts to stimulate industrial innovation and productivity. In addition to the Federal expenditures for research and development, the program proposes longer-term investment in capital facilities for research and development and measures to induce competitiveness domestically and abroad. Specifically, the program proposes:

A liberalized and simplified form of business tax depreciation to encourage rehabilitation of existing facilities and investment in new plants and equipment;

A partially refundable business tax credit to benefit those businesses—distressed firms in industries such as autos and steel as well as small businesses just starting up—which have no earnings, yet have substantial investment needs;

A tax credit to offset the increase in the employers share of the social security tax;

A variety of measures to increase exports;

Implementation of initiatives proposed by the White House Conference on Small Business to help in the start-up and operation of small businesses; and

Creation of a President's Economic Revitalization Board to foster public-private sector cooperation in dealing with the complex issues of industrial policy.

Joint Government-Industry research programs.—OSTP has stimulated development of two research initiatives that affect the pattern of cooperation between the government and industry and also foster cooperation within industrial sectors. In each case, the objective has been to plan new activities that have substantial prospect for long-term payoff but which would not likely take place without collective cooperation within an industrial sector and between government and industry.

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The first of these is the Cooperative Automobile Research Program (CARP) which we have discussed in detail before this Committee on other occasions. CAPR is intended to increase the level of basic research underpinning automotive technology and, thus, to contribute to the design of automobiles in the 1990's and beyond which are more economic to manufacture and operate, and which exhibit greater fuel efficiency, safety, and reduced pollution. CAPR-supported research will be carried out at universities, at private and government research laboratories, and in the industry's own research centers in such areas as combustion, structural mechanics, electrochemistry, and aerodynamics, materials and science and processing, tribology, and catalysis.

The Department of Transportation, the National Science Foundation, and possibly other agencies, and the five domestic automobile manufacturers will participate in the program. The large scale involvement of universities represents a new opportunity for that research community to make a significant contribution to a major industry. The government and the industry have agreed on a planning target of $100 million annually to be reached by 1984.

A second program for government cooperation with industry is the Ocean Margin Drilling (OMD) program. This program of frontier research and technological development will enable us to characterize the passive and active continental margins. We have proposed a cost-sharing effort through which the government and companies in the oil industry each would contribute about $350 million over a ten-year period. This activity, which will go forward if preliminary engineering work now underway shows the project to be feasible, will lead to advanced developments in riser technology and well control to permit drilling in water depths of 3 to 4 kilometers and in the sedimentary rocks to a depth of about 6 kilometers.

These two programs represent significant developments in government-industry-university cooperation. Each has required a careful study of prospective research and engineering objectives, a clear delineation of appropriate government and private sector roles, a mutual willingness to explore new patterns of work, and objective examination of antitrust, patent policy, and other issues that have been real or perceived barriers to cooperation. A careful line had to be observed in developing a program satisfactory to industry legal counsels, the Justice Department and the Federal Trade Commission.

In my dual role as a member of the President's staff and Director of OSTP, with a statutory mandate to coordinate interagency programs, I was able to organize the participation of several government agencies and to clear the programs through the White House. The CARP and the OMD programs may serve as models for exploring joint ventures in other sectors, which have similar attributes—a high degree of shared private and government interest, the need to organize cooperation of the major firms of an industry in ways that do not impede competition, and a long-term but high rate of return to joint investment. The economic program announced late last month includes a commitment for some additional cooperative inter-sectoral programs and we are exploring the possibility of initiating one or two more.

Regulatory reform

Discussions of industrial technology and innovation invariably turn to the regulatory system. Indeed, one of the most striking changes that has taken place in our governmental system over the past two decades has been the rapid growth of regulation to achieve socially desired objectives. In many cases, regulation involves important technological decisions. Air and water pollution control, energy conservation, hazardous waste disposal, occupational health and safety, aircraft safety, and nuclear power safety are prominent examples. It was clear to us early, therefore, that regulatory matters would be a major concern to OSTP.

In the past four years, the Administration has taken a number of steps to improve the regulatory process. I will not review these here. OSTP focuses on the use of high quality scientific and technological data and improved methods or risk assessment in the regulatory process. It is true that the fundamental political, and indeed, adversarial nature of the process does not provide an ideal environment in which the technical data from diverse sources may be pooled and objectively examined. In many cases, the time pressures set by statute, court decisions or other events do not allow the orderly resolution of technical conflicts. Yet, regulation is one of many highly complex decision-making processes for which scientific and technological judgment must be joined together with economic and other perspectives for their resolution.

For example, an issue of major significance is regulatory treatment of potential carcinogens. As our instrumentation and diagnostic capabilities have improved, we have increasingly discovered that many man-made substances introduced into our environment may be carcinogenic. However, government policies for dealing with these problems have been inconsistent. OSTP, therefore, undertook a study analyz-

ing the scientific principles underlying carcinogenic risk assessment and laying out framework for identifying and characterizing chemicals which might pose a carcinogenic risk. The resulting report was a factor in establishing a uniform government policy for controlling chemical carcinogens. The agencies agreed to a set of general concepts and principles for use in determining whether a chemical may caused cancer, assessing its risk, setting regulatory practices, and undertaking regulatory actions.

One of the most dramatic developments in all of science is the application of recombinant DNA techniques to many problems of basic biology and to production of needed hormones, vaccines, chemicals, and other pharmaceutical and agricultural products. Four years ago, the public had been greatly alarmed by controversy within the molecular biology community over the safety of such research. A determined effort led by Dr. Donald Fredrickson, Director of NIH, and joined by an effective Interagency Committee, including OSTP, brought public health insights, risk assessment experiments, new data, and a more objective attitude to policy discussions. Congressional hearings also helped air all sides of this complex issue and promote a reasoned assessment of the putative risks involved. The prudent course undertaken has allowed very rapid progress in this work, permitted university and industrial efforts to grow and flourish, and assured workers and environmentalists that great care is, indeed, being exercised through the NIH guidelines and through educational efforts on industrial applications.

Some areas of regulation require a range of tools to evolve a sound policy. For example, OSTP has worked extensively on government policy regarding the introduction of diesel engines into the passenger car fleet. OSTP encouraged DOE to accelerate and expand its planned diesel health effects program as a complement to EPA's program, and worked with OMB to get its budget approved. Second, OSTP, with the strong support from the other White Hosue offices, requested DOE, DOT, and EPA to fund jointly a major ($1.3 million) study by the National Academy of Sciences (NAS) to analyze a range of federal policy alternatives and to ensure the soundness of the research programs of both the public and private sectors. The study is scheduled for completion in December, 1980. Whether other measures will be necessary to deal with the possible carcinogenicity of the diesel exhaust will be determined next year after the NAS report is completed and the research programs are further along.

Examples such as these illustrate the valuable contribution of scientifically valid data to the regulatory decision-making process and leave little doubt that OSTP will continue to play an important role in improving the Federal regulatory process and in upgrading the quality of scientific analyses employed by regulatory agencies.

Health research

Health policy initiatives of this Administration have emphasized wider availability of health care services; prevention of injury, disease, and disability; control of health care costs; and expansion of health insurance coverage. Such health service initiatives generally are not considered to be within the purview of science and technology policy. Yet, their successful development and implementation require decisions informed by the best available scientific information, programs supported by sound basic and applied research, and evaluation and impact assessment based on complete data. OSTP has focused on the scientific and technological issues in health care and identified specific key issues for consideration.

An example is the controversy over the role of new health care technologies in escalating health care costs. Many observers equate the two, singling out specific technologies—for example, computed tomography and coronary artery bypass surgery—as causes of cost inflation. Cutting wasteful and excessive health care costs without inhibiting technological innovation requires (1) objective analysis of incentives in the system and identification of those which may wrongly reward inappropriate or excessive use of technologies, and (2) wise assessment of the safety and efficacy of new technologies. This has been the primary health policy focus of this Office.

OSTP is working with the appropriate Federal agencies to address these needs. NIH is holding consensus development conferences on the safety, effectiveness, and appropriateness of medical practices and procedures; the new National Center for Health Care Technology (NCHCT) and its Advisory Council are assessing selected health care technologies and providing advice on government reimbursement for their use; and OSTP, he NCHCT, and the Health Care Financing Administration are collaborating on a model system for benefit/cost assessments of new technologies and for better reimbursement policies.

Basic knowledge of the human organism is fundamental in addressing successfully our difficult health problems. This Administration has supported rational growth of our biomedical research enterprise and of its Federal guardian—the National

Institutes of Health. Each year the President has proposed a 10 percent increase in the NIH budget over his request of the previous year. Consistently, Congress has increased the NIH budget, resulting in rapid unplanned growth, with money frequently allocated according to criteria other than the needs and opportunities of the field. The resulting instability among the various NIH institutes and among our research universities has been particularly damaging to basic research. Accordingly, OSTP has joined with Congress, NIH, the biomedical research community, and OMB to develop a consistent approach to NIH budget growth. The fiscal 1981 NIH budget proposes stabilizing the number of new and competing research grants at around 5,000 awards. This approach will provide continuity and stability, especially for individual investigator-initiated research.

OSTP has taken parallel actions to strengthen the biomedical research establishment. Over the last three years we have emphasized basic research across the board. Secondly, we have stressed the importance of upgrading scientific resources fundamental to world-class scientific work. Lastly, we are working with NIH to reduce the administrative burden on researchers through encouraging shorter grant applications, simplified reporting, streamlined review procedures, and innovative approaches to grants funding and management.

Agricultural policy

Advanced agricultural research is vital to our future and that of other nations. Our agricultural productivity must grow to meet ever increasing domestic and worldwide needs. Yet, our land is producing at its biological limits within the boundaries of present knowledge and technology. Prime agricultural land is being diverted to other uses or to nonfood crops such as energy, fiber, and chemical feedstocks. Our farmers are turning to other occupations. Many agricultural chemicals and practices are being restricted for valid health, safety, and environmental reasons. Lastly, critical agricultural resources such as energy, soil, water, chemicals and capital are more expensive.

Our agricultural policies emphasize the importance of a strong agricultural research enterprise in increasing agricultural productivity. OSTP has worked closely with the Secretary of Agriculture in stabilizing and increasing agricultural research budgets and in strengthening the management of the Department of Agriculture's research programs. The DOA Director of Science and Education now is equivalent to an Assistant Secretary and is a member of the Secretary's budget and policy review group. Program review and evaluation procedures are improved to assure that scarce resources fund the highest quality, most relevant research.

OSTP and the DOA have given special attention to the role of the Federal government in agricultural research and to the relationships between the government and other partners in the agricultural research enterprise—the States, the private and State universities, producers, consumers, and business. We are exploring new joint government-industry research programs, in such areas as food processing, occupational health and safety, and animal fats. The new DOA competitive research grants program, now in its third year, has been especially successful. This small program supports high priority, basic research in plant science and human nutrition. It has attracted a number of investigators to the field, including many new, young researchers as well as accomplished scientists from other research areas.

The demand in our own country as well as abroad for freshwater and marine plants and animals for food, fiber, and biomass has focused attention on the need to strengthen government aquaculture research and development activities. At the direction of the President, OSTP has worked with the relevant agencies and Congress to develop a National Aquaculture Plan, to study those factors which may constrain the American aquaculture industry, to institutionalize interagency coordination and joint programing, and to develop appropriate and effective aquaculture legislation.

Energy and environmental R. & D.

Energy policy goes far beyond the realm of science and technology, encompassing broad economic, political, and social considerations both domestically and internationally. Nevertheless, science and technology are essential components of the solution to our energy problems and ultimately influence all of them. What alternate energy resources and technologies we choose to pursue, how we develop them over time, what their safety, reliability and environmental impact are, and what bearing they might have on economic policy, national security, and our international relations—all these and other questions are tied to the knowledge and capabilities that flow from our energy research and development.

Our current energy policy emphasizes reliance on a range of energy initiatives. These include conservation and decontrol; synthetic fuels development; the continu-

ing role for nuclear energy with measures to improve safety, to control nuclear weapons proliferation, and to manage radioactive waste; geothermal energy, major expansion of solar energy research and incentives for use of existing solar technology; and long-range resource development in areas such as fusion. In addition, we have significant breeder reactor research and development efforts underway to meet potential future needs.

My staff and I participate in the energy budget review and other activities of the Executive Office where our capabilities in energy research and technology make our participation appropriate. Today I will highlight several of these activities.

As you are aware, the accident at Three Mile Island revealed substantial shortcomings on the part of Government and the utilities in assuring the safety of nuclear power. The President thus established a Commission to investigate the accident and its cause. This Commission, chaired by John Kemeny, made some 44 recommendations for change, including modification of the structure and procedures of the NRC, improved training of operating personnel, and greatly strengthened emergency planning and response, among others. The President has adopted virtually all these recommendations. The reorganization plan submitted to the Congress should serve to assist in the development of a unified and more reliable nuclear safety regulatory program. The President's nominee to become the next Chairman of the commission is awaiting Senate confirmation.

OSTP has been closely involved in this issue from its outset. My staff and I helped to establish the Kemeny Commission. Dr. John Deutch, the then Under Secretary of Energy, and I chaired the internal group that developed a response on behalf of the Administration. We have been actively involved in the task of assuring the safety of nuclear power, and expect this task to continue.

For over two years, OSTP has participated in the President's Interagency Review Group on Nuclear Waste Management (IRG). The particular roles played by OSTP were to chair the technical working group that examined alternative technical strategies for the disposal of high-level radioactive wastes and spent fuel and, in the later phases of the review, to coordinate much of the preparation of the IRG report, the recommendations to the President, and the subsequent announcements. On February 12, the President sent to the Congress a plan for a comprehensive national radioactive waste management program. The program outlines the technical strategy that will be followed in working toward the construction of one or more mined, geologic waste repositories, the procedures that will be followed for State and local government and public participation, provisions for interim storage of spent fuel from nuclear reactors, plans for low-level waste disposal and for remedial clean-up action at disposal sites and also at uranium mill tailing sites, and regulatory actions necessary to implement the program.

One of the most serious energy/environmental problems that may confront our nation in the next century derives from the buildup of carbon dioxide in the atmosphere from the burning of fossil fuels and from deforestation. Plausible projections of future carbon dioxide concentrations suggest a doubling by the middle of the next century. Since carbon dioxide is a powerful absorber of thermal radiation in a region of the spectrum in which the atmosphere is otherwise quite transparent, small changes in the concentration of this trace constituent could have major effects on the heat balance of the earth. The consequence might be substantial changes in climate and large impacts on society.

This is a problem about which greater knowledge and sophistication are needed. OSTP therefore sponsored two studies by the Climate Research Board of the National Academy of Sciences. The first study examined the status of climate modelling in order to determine the climatic consequences of a doubling of carbon dioxide and the level of uncertainty in our knowledge. The study indicated that there was reasonable agreement among different approaches that a doubling of carbon dioxide would result in major climatic shifts. A second study addressed the way in which we might examine and address the potential social and economic impacts of increased carbon dioxide concentrations. My Office is currently discussing a further comprehensive review of the carbon dioxide issue as required by the recently enacted synfuels legislation.

National security research and development

Our national security depends in large measure on our technological capability, particularly on our ability to meet future challenges by deploying new weapons systems that embody more advanced technology. Our military investments in new technology over the years have contributed immeasurably to our security. Now, as other nations are becoming more proficient in science and technology, we must make certain that our research remains at the frontier of knowledge. For these reasons, an important part of OSTP's activity has been to work with the President, the Office of Management and Budget, and the Department of Defense to restore

the declining support for research and technology in defense budgets during the first half of the 1970's. As a result, the cumulative growth in the technology base from fiscal years 1978 to 1981 will be over 50 percent, including an increase in basic research of nearly 65 percent.

The outside review of basic research in the Department of Defense, which I organized at the request of Harold Brown, was well received by the Department and directly led to the major increases in support for basic research. DOD also undertook several other actions in agreement with the report's recommendations. For example, the Deputy Under Secretary for Research and Advanced Technology was assigned the responsibility for oversight and management of the entire DOD basic research program. The Secretary of Defense has issued a policy statement clarifying the Department's view of the role of basic research. DOD is also using some of its real growth in basic research to provide funding to new performers, especially researchers from universities.

As Director of OSTP, I am involved in the development of policy on national security issues. My staff and I chair or sit on various Cabinet and sub-Cabinet level committees and working groups of the National Security Council and participate in the processes established by the Office of Management and Budget for analyzing the defense, intelligence, and foreign assistance budgets.

I have been the Chairman of three NSC Policy Review Committee (PRC) groups, formulating the policy options for the China science and technology agreement, reviewing our space policy, and reviewing our telecommunications policy. At the request of the President, on a number of occasions I have also assembled special committees of prestigious outside scientists and engineers to provide him with independent advice on key national security issues. These have included M-X and cruise missile weapons development, the nuclear weapons test program, and arms control issues such as verification procedures for the comprehensive test ban treaty.

International scientific and technological cooperation

The President's Message to the Congress on Science and Technology spelled out four themes that have shaped U.S. policy in international scientific and technological cooperation: pursuit of new international initiatives to advance our own research and development objectives; development and strengthening of scientific exchanges to bridge political, ideological, and cultural divisions between this country and other countries; formulation of programs and institutional relationships to help developing countries use science and technology beneficially; and cooperation with other nations to manage technologies with global impact. Throughout this Administration, OSTP has actively pursued bilateral and multilateral international programs in science and technology in accord with these themes.

In January 1979, the President and Chinese Vice Premier Deng Xiaoping signed an agreement for science and technology cooperation. Since that time, our two countries have signed 13 protocols for bilateral cooperation in a broad array of areas including space, student and scholar exchanges, agriculture, public health, environmental protection, hydropower development, and earth sciences research. In January of this year we reviewed, in China, the rapid and remarkable progress that has been made in the implementation of each of these protocols during the first year of normalized relations. At that time we also signed an agreement for cooperation between our two prestigious national academies of science. The S&T Agreement provides for facilitation of contacts between the U.S. private sector and the Chinese to support their modernization efforts in energy and other sectors. It is clear that R&D cooperation naturally leads to enhanced commercial relationships.

Cooperation with the Soviet Union has changed dramatically as a result of that country's invasion and continued occupation of Afganistan. The Administration has taken steps to demonstrate that such actions will have an adverse effect on all forms of cooperation, including scientific exchanges. The President has made the deliberate decision to focus our restrictive measures against specific activities, not against the framework of our bilateral agreements themselves. Only those substantive exchanges which are of overriding scientific interest to the U.S. or which involve humanitarian concerns, such as health or the environment, will be continued under the present circumstances. It is ironic that this change in policy took place at a time when many U.S. participants in U.S.-USSR cooperative science programs were beginning to feel that programs of true mutual benefit were at last underway. Our decision to keep the framework of cooperation intact reflects this sense of U.S. gain from the programs. At a future time when conditions change, we may want to resume some or all of our cooperative programs with the Soviet Union.

A major step in further expanding the already extensive scientific cooperation between the U.S. and Japan was the signing of a bilateral agreement for cooperation in energy R&D projects, such as coal liquefaction, nuclear fusion, and geothermal and solar energy. President Carter proposed to the Japanese a complementary

program of joint R&D in various non-energy areas of global importance such as space, environmental energy. President Carter proposed to the Japanese a complementary program of joint R&D in various non-energy areas of global importance such as space, environmental protection, health, agriculture, and resource conservation. These joint projects are based on the concept of mutual interest and benefit. Manpower, physical resources, and financing of these large-scale projects will be shared. The scale of these programs represents a new concept in international S&T cooperation.

Impressive progress has been made in our science and technology relationship with Mexico. During the President's February 1979 meeting with President Lopez Portillo, our two countries signed a memorandum of understanding to inaugurate cooperation in a number of areas including arid lands agriculture and energy R&D. In October 1979, I led a delegation of senior government scientists and science officials to a number of countries in South America and the Caribbean, including Venezuela, Brazil and Peru. We also met with representatives of the Andean Pact and Caribbean regional organizations. As a result of consultations with leaders of these areas, numerous joint S&T activities are underway and many additional ones are planned.

Tomorrow, I will lead a high-level scientific delegation to Africa where we will explore with Nigeria, Zimbabwe, Senegal, and Kenya, the potential for various kinds and levels of scientific and technological cooperation. We believe that the respect for our science and technology can be a firm and stable stand in the constantly shifting web of relationships in the Third World.

The Institute for Scientific and Technological Cooperation (ISTC)

As the Subcommittee will recall from my earlier appearances, one of the Administration's principal initiatives to foster scientific and technological cooperation with developing countries is the proposal to create an Institute for Scientific and Technological Cooperation. The ISTC was authorized by Congress in 1979 to serve as a mechanism to facilitate the application of science and technology to the most important problems of developing countries.

At this point the status of the ISTC is still unresolved. Since the enactment of the Foreign Assistance Bill authorizing the establishment of ISTC, the inauguration of the Institute's program has awaited final action by the Congress on the Foreign Assistance Appropriations Act for fiscal year 1980. Because final House and Senate approval of the Conference Committee's report on this bill has not occurred, fiscal year 1980 programs will operate under authorities of a continuing resolution. Since ISTC was not in existence in fiscal year 1979, no appropriations for ISTC are authorized under the continuing resolution for fiscal year 1980. In light of this, the Administration in now reviewing options with respect to the funding and location of the Institute in fiscal year 1980 and fiscal year 1981. However, I want to stress the Administration's commitment significantly to increase technical assistance in our bilateral aid programs.

Space policy

The United States space program has made dramatic progress since its inception almost a quarter century ago. Now our national space program is entering a new stage of maturity—one in which we will receive increased dividends through scientific exploration and technological applications.

The Carter Administration's space policy is designed to carry us successfully into the next era in space. We have for the first time the opportunity for choices with regard to direction and pace. First, our space policy will reflect a balanced strategy of space applications, space science and exploration, and technology development. Second, our space policy will become more evolutionary, rather than centering around a single engineering feat. Our space policy is sound, progressive and fiscally responsible—very appropriate for this pre-Shuttle period.

Completion of the Shuttle is our highest priority. The Shuttle will be central to our national efforts in space science, commercial space utilization, defense, and technological leadership. In addition, its completion could release significant funds for new space science and applications projects—a matter of some concern to members of the space science community who fear the demise of planetary exploration and space research.

Despite budgetary constraints our space science and exploration programs continue to be challenging. We have exciting missions now underway. The Voyager craft, having explored Jupiter, will continue on to Saturn and then Uranus. Under development are Galileo, which will explore Jupiter, the Solar Polar Mission, several Explorer missions, the Space Telescope, and of course, Spacelab. Work on the new Gamma Ray Observatory will start next year. In addition, we are considering two new programs—the Venus Orbiting Imaging Radar and a Halley Comet mission.

II. THE DECADE AHEAD

Mr. Chairman, I wish to conclude my statement this morning with a very brief look ahead.

As we enter the decade of the 1980s, we are devoting increasing attention to future trends in science and technology and their impact on domestic and international affairs.

In this regard, the Five-year Outlook is particularly valuable. The "Outlook" itself, together with the supporting source materials, provides a 5-year prospective on several broad policy areas as well as concise syntheses on eight specific topics—energy, materials, transportation, space, agriculture, health, electronics, and risk management.

As I look toward the future, I visualize not a de-emphasis on technology, as some would have it, but, rather, an increasing focus on the appropriate and responsbile development and application of technology to meet domestic and international needs.

For example, as it becomes ever clearer that a major cause of inflation is weakness and slugishness on the supply side of the economy and that our competitiveness internationally depends upon increased industrial productivity, more and more attention will be given to revitalization of our industrial sector. Science and technology will play a major role in solving many of the complex problems confronting existing industries and in making the transition to many new industries for which we are, and have been, laying an R. & D. base (e.g., biotechnology).

Related to this emphasis on industrial innovation and productivity will be further rationalization of the regulatory process. Although protection of human health and safety will remain paramount, increased attention will be given to assuring that regulatory decisions are based on the best possible science and that the resulting regulations are implemented in such a way as to minimize the adverse impacts on industrial innovation and productivity.

Perhaps nowhere are the expectations of science and technology as high as they are in energy. As the Nation struggles to decrease its dependence on foreign energy sources and the economic, social, and environmental costs of proposed alternatives become clearer, technology is increasingly looked to for answers. Even more sophisticated means of locating energy resources, introduction of the next generation of current energy technologies, and development of alternate technologies for central and local power generation will characterize the 1980's.

In terms of the conduct of research and development, this decade will see constructive changes in the relationships among the major performing institutions. More and more, the National interest will be served by cooperation among government, universities, and industry. University-industry linkages will help stabilize university science programs and stimulate innovation. Joint government-industry research programs, such as CARP, will focus the country's best research talent on generic research problems not otherwise being adequately addressed. The government and academia will continue to explore new institutional relationships which maximize the performance of research and minimize the intrusion of Federal rules, regulations, and procedures. The enhanced support we are providing will lead to major scientific discoveries.

Internationally, science and technology will be a key factor in maintaining our national security and our standing in the world. Our relations with the Third World will take on a new dimension as we increasingly focus on direct technical assistance as the major element in our bilateral aid programs.

Mr. Chairman, I believe that the next five decades will test both the nation and the world in a way that neither has been challenged before. Domestically, our most important problem may be one of governance: the complexity of our government at all levels, the rise of special interests, the compartmentalization of government, and polarization of our people contribute to our inability effectively to move forward toward consenses on many fronts.

We face even more difficult problems internationally. At a time when we should be expanding our commitments to international activity, especially through the support of scientific and technical assistance to the developing nations, many would cut these funds still further. The Global 2000 report to the President catalogues many of the seemingly overwhelming problems facing mankind, worldwide: abject hunger of over one billion people, the economic, social, and environmental consequences of expanded world-wide energy consumption, deforestation, reduction of genetic stock, declining agricultural productivity, continued population growth, and numerous other fundamental problems that must be dealt with responsibly. Arms limitation and control remain a primary concern. Effective use of resources, including ocean resources, will also be a critical test for all nations.

There are some deleterious effects of technology, of course, that must be addressed. But, over all, I remain optimistic that these can be controlled. Science and technology will yield unanticipated positive results that will contribute substantially to the resolution of global issues. In this century we have witnessed a number of such advances that have profoundly affected agriculture, communications, and transportation. Our task in the 1980's is to insure that our national commitment to science and technology remains vigorous so that these unanticipated but profound, beneficial advances continue to take place.

Mr. Chairman, this concludes my formal statement. My colleagues and I would be pleased to answer your questions.

Senator STEVENSON. Dr. Averch, I invite you, sir, also to summarize your testimony. If you can do that, the full statement will be entered in the record.

STATEMENT OF DR. HARVEY AVERCH, ASSISTANT DIRECTOR FOR SCIENTIFIC, TECHNOLOGICAL, AND INTERNATIONAL AFFAIRS, NATIONAL SCIENCE FOUNDATION

Dr. AVERCH. Thank you, Mr. Chairman. I will be very brief and try to make a few salient points about the NSF's experience in producing the annual science and technology report and the 5-year outlook on science and technology.

There are two generic points that I hope you would bear in mind. First, the two reports are part of an ocean of information about science and technology. And I would treat the two as a framework for viewing all of that other information—the Global 2000 Report, the President's message on science and technology, the Three Mile Island report, and so on. In my view, the annual science and technology report and the 5-year outlook, plus the National Science Board's science indicators, put all of the other information in context. I think this meets the intent Congress had in mandating them.

Second, the process of preparing these reports is as important, as the substantive output itself. As the NSF staff prepared the materials—and this came as somewhat of a surprise to us—we found ourselves in very intensive discussions with OMB, OSTP, and other R. & D. agencies, and I believe greater understanding of respective roles was achieved among all parties through the discussion process.

The 5-year outlook was written without budget constraints. Agencies tended to submit what might be called blue-sky proposals. OMB examiners viewed matters in terms of a targeted budget cycle. When NSF entered, discussing the next 5 years, an important effect on the planning process took place.

I will try to highlight differences between the second annual report and the next 5-year outlook. We have had both of them evaluated. With respect to the annual report, we have reached an equilibrium in our thinking about its format. It consists of two parts: a review of the administration's actions on the policy issues in science and technology and a set of definition briefs which explain in lay language important science and technology-related problems faced by the country.

In the second annual science and technology report, we cover risk management, earthquake prediction, privacy, procurement, and computer data bases. Evaluators agreed that these definition briefs should be uniquely valuable for the Congress. And, I hope

this will be true. The second annual report will be available shortly and you may test the proposition.

We have also evaluated the 5-year outlook. A number of different science policy groups across the country have written formal evaluations for us. These have yielded suggestions for improvement which we will try to incorporate in the next outlook.

I think the overall thrust of these evaluations has been positive. It is fair to say more integration of the separate components is necessary, and the overview section should be more policy-oriented, rather than topic-oriented as in the first outlook.

It is technically very difficult to integrate such vast amounts of material, and of course groups with diverse interests view these materials differently. So, there is no unique way to produce a 5-year outlook. In response to the request for a stronger policy focus and more integration, we will be bringing the various groups together who are preparing source materials to establish better product integration.

I would note that while the National Academy of Sciences is a major contributor it is not the only contributor. For example, the Social Science Research Council is preparing a number of chapters for us on social problems and social technology for the second outlook, and the American Association for the Advancement of Science is preparing a set of integrated policy papers. By means of these read-across types of activites, we hope to encourage a priori structural relationship in the source materials.

The NSF staff is also working very hard with the various Federal R. & D. agencies to produce a coherent set of statements. The next outlook will be organized by budget function rather than by particular agency submissions. That should be a positive step. We now have, as Dr. Press noted, improved relations with these Federal agencies. Even though OSTP has staffing constraints, a specialist in that office has been assigned to work with our NSF staff in the construction and review of these reports.

So, we are learning by doing, and we are coming closer to what the Congress envisoned in the OSTP Act.

I have one final comment, concerning the cycle of the reports. Both reports are very resource-intensive and very staff-intensive. The 5-year outlook cost us about $1 million. There is legislation pending which would put the 5-year outlook on a 4-year cycle, appearing in the first year after each Presidential election.

This 4-year cycle would give us a chance to more clearly highlight scientific and technological shifts, discontinuities, and changes. And, it would give us a chance to assimilate lessons learned. Technically, we are supposed to adhere to an annual cycle. Experience has shown it really takes 3 years or so to construct these outlooks if they are to be credible, rigorous and policy-oriented, as I think we all agree they should be.

This concludes my comments, Mr. Chairman, and I will be happy to answer any questions.

Senator STEVENSON. All of the comments I have heard about the outlook have been very positive, and we certainly feel that you deserve the highest commendation for the work that went into the 5-year outlook under circumstances that we recognize were difficult.

While I haven't read it, our staff, as you know, has read the second annual report, and they feel there is a tremendous improvement in that report. The only adverse comments that I have heard, which I mentioned earlier talking with Dr. Press, was about that overview, and you indicated too some concerns about it.

Is there any reason, in your opinion, why—well, what is your opinion? Would it be better off—the responsibility for preparing that overview—wouldn't it be more appropriately placed in OSTP?

Dr. AVERCH. You mean the 5-year outlook?

Senator STEVENSON. Yes.

Dr. AVERCH. Well, in my own view, NSF has the resources and contacts in the community to do both an overview and integrate the source materials. OSTP has reviewed, commented, and critiqued the overview we prepared, as has the domestic policy staff of the White House. So, as long as there are people with science policy experience in OSTP and the White House, I think we can be quite effective in preparing both the overview and the source materials.

I do think that in the next outlook, OSTP involvement in the process will be markedly greater. And, we have established a reasonably efficient process for getting the administration position without placing an undue burden on OSTP.

Remember that the outlook, the overview statement, and NSF Director Richard C. Atkinson's statement do reflect the administration's position. The outlook was cleared through the White House. It may be unnecessary to specify the particular organizational locus, so long as Congress can be sure that the administration is, indeed, looking at these statements and that they do, in fact, reflect the administration's policy. I assure you, that in the case of both the second annual report and the 5-year outlook, they do.

Senator STEVENSON. And the resources of the National Science Foundation are adequate for the preparation of the 5-year annual outlook—I mean the 5-year outlook and the annual report?

Dr. AVERCH. Well, every agency is staff limited, and these reports are particularly staff-intensive. We have requested some additional staff from OMB to prepare the two reports, and we are optimistic about the outcome. The staff constraint is perhaps more important than dollar constraints. It takes a lot of coordination, a lot of integration to produce a good product.

Senator STEVENSON. If you have the money, why can't you get the people?

Dr. AVERCH. The OMB is more sensitive, in a sense, about people than dollars. We use regularly appropriated NSF funds. We also labor under the general agency manpower ceiling, and of course my own directorate has a subceiling. And, everybody must compete for additional personnel.

Senator STEVENSON. Those are established in the budget, those ceilings?

Dr. AVERCH. Yes. They are established by OMB as part of the budget process. I do think we are using the staff we have well—and I have pulled from our regular resources in a cost-effective way—I think the products reflect that.

Senator STEVENSON. Does that mean that other activities of NSF are getting sacrificed for the preparation of the outlook?

Dr. AVERCH. No. You understand, we have general responsibilities for science and technology policy research, and I have allocated resources internally to meet this particular demand, which is a high priority.

[The statement follows:]

STATEMENT OF DR. HARVEY AVERCH, ASSISTANT DIRECTOR FOR SCIENTIFIC, TECHNOLOGICAL AND INTERNATIONAL AFFAIRS, NATIONAL SCIENCE FOUNDATION

Mr. Chairman and Members of the Committee:

I am pleased to discuss the National Science Foundation's experience in producing two of the reports required by the Science and Technology Policy, Organization and Priorities Act of 1976: the Annual Science and Technology Report and the Five-Year Outlook on science and technology. Broadly speaking, the mandate for the Annual Report and the Outlook expresses Congress' desire that information be collected and integrated in making national policy choices with important scientific and technical components, and also to encourage Federal science and technology agencies to take a longer-range analytical approach to their responsibilities. We are trying to meet both these objectives.

There are two general points I want to make before discussing the reports in detail:

First, neither report should be viewed in isolation. The Annual Report and Five-Year Outlook are, of course, legislatively and substantively linked. In addition, NSF prepares a number of other reports, most notably the annual National Science Board reports, including the biennial Science Indicators. Taken together, these reports provide a description of the past, present, and future of U.S. science and technology. Further, many other reports and studies appear each year that bear on science and technology policy. For example, the Global 2000 report to the President prepared by the Council on Environmental Quality and the State Department contains much resource material relevant to science and technology policy.

Second, we have come to recognize that the process of designing and producing the Annual Report and Five-Year Outlook has an important effect on policy planning. The process may, therefore, be as important as the substantive content of the reports. When non-Federal organizations, Federal P&D agencies, OMB, and OSTP all become involved in thinking about the most important accomplishments of the recent past, and the most significant issues for the future, some changes are already occurring in the planning process.

The first Annual Science and Technology Report was transmitted to Congress by President Carter in September 1978. The second Annual Report is just now being printed, although I understand that your staff has had an opportunity to study final page proofs. Preparations for the third Annual Report are well underway. The second and third Annual Reports both contain two major sections: (1) a review of Administration actions relating to science and technology for the year ending with the submission of the President's budget to Congress; and (2) papers or briefs on policy issues stemming from recent developments in science and technology.

In the case of the second Annual Report, these papers cover such issues as public participation in science and technology decisions and the Federal rose in science and technology decisions and the Federal rose in the development and commercialization of new technology. They also cover the assessment and management of risk, earthquake prediction, privacy, and computer data bases. These briefs are designed to serve as short, readable introductions to public policies involving science and technology that are already emerging or are likely to emerge in the very near future. Evaluators of the Annual Report felt that these briefs had a particularly high potential value for Congress. We hope this proves to be true.

The first Five-Year Outlook on science and technology was transmitted to Congress in May. Unlike the Annual Reports, which are designed to review recent Administration actions and point to science and technology policy issues that are already clearly emerging, the Five-Year Outlooks are to look to the future and to analyze the general development of science and technology in relation to national and international problems.

When we were given the assignment to produce the first Outlook, in the President's Reorganization Plan No. 1 of 1977, it was clear that there was no established way to construct such a document. Our strategic approach was as follows: We obtained and reviewed a wide range of substantive input from Federal and non-Federal organizations and individuals. Then we compared those inputs to determine what common themes emerged from them. Through this comparison we derived the eight problem areas into which the first Outlook is organized. These eight are:

energy, materials, transportation, space, agriculture, health, the electronic revolution, and the management of hazards and risks. For each area we tried to provide a guide to what we regard as the most significant problems, opportunities, and constraints.

We are aware that our perspective of the future is not unique. For that reason we decided to reproduce all of the source materials validated by our peer review process in a companion volume—Volume II—so that those with different perspectives can organize them in a different way and, in a sense, produce their own Outlook. We believe publication of validated source materials is a necessary design criterion for Five-Year Outlooks.

As a part of the evaluation of the first Outlook and planning process for the second one, we asked five university-based science and technology policy groups across the country to conduct extensive, formal reviews of the source materials of the first Outlook and our own synthesis of those materials. These evaluations have yielded several specific suggestions for improvement, which we are trying to meet in designing the second Five-Year Outlook.

In broad format, the second Outlook will be similar to the first. It will consist of a volume of source materials, and a volume whose core will be an analysis of those materials. As was the case for the first Outlook, three different types of materials are being assembled as sources: (1) Materials written from the perspective of practitioners of science and technology; (2) materials based on inputs from Federal agencies who have programmatic responsibility for science and technology; and (3) papers written by specialists in science, technology and public policy. However, there will be some important differences reflecting the consensus among the evaluators that there ought to be stronger a prior relations among the source materials. In particular representatives of organizations contributing to the source materials meet frequently with NSF staff and with one another to establish these relationships.

The National Academy of Sciences will be a primary contributor to the practitioners' component of the source materials. The Social Science Research Council will also submit five or six chapters dealing with significant problems and opportunities associated with the social and behavioral sciences.

Dr. Ralph Gomory, who is also testifying today, can answer any detailed questions you may have on the Academy's contribution to the second Five-Year Outlook. Our preliminary reading of their plans indicates that they will be more sharply focused on the relationships of developments in science and technology to significant national policy issues than was the case for the NAS contribution to the first Outlook.

The source materials for the policy component of the first Outlook consisted of fourteen papers by individual specialists. While critics judged many of these papers of be highly valuable, there was no formal relationship within the entire set and with the other source materials. Therefore, we have asked the American Association for the Advancement of Science (AAAS) to organize a series of special seminars to review and provide connections among draft papers by individual authors. The AAAS project is being guided by a special committee chaired by former Congressman Ray Thornton of Arkansas.

The Federal agency contributions to the second Outlook provide one of the most significant departures from the first Outlook. This component of the first Outlook consisted of individual contributions from the 21 agencies which are responsible for 97 percent of total Federal R&D expenditures, Publishing side-by-side statements about the views of 21 agencies on significant future issues related to science and technology was, in itself, an important step in providing information useful for policy definition and discussion. In the course of assembling these contributions, we occasionally found ourselves facilitating discussions about the future policy between agency representatives and OMB budget examiners and, thus, indirectly affecting the budget planning process.

However, critics of the first Outlook pointed out that while the agency statements were useful, the individual agency format made it difficult, at best, to discern relationships among the programs and responsibilities of the different agencies. To address that problem, we plan in the second Outlook to organize the Federal agency contributions according to budget functions such as energy, national security, health, general science and natural resources. Each contribution will be based on inputs from all agencies that are concerned with that particular function, with a designated lead agency assuming responsibility for assembling the individual inputs and producing a first draft. For example, the Department of Transportation will prepare an integrated statement on the transportation function spanning all agencies.

It was the consensus of the evaluators of the first Five-Year Outlook that NSF's synthesis of the source materials for the second Outlook ought to focus more

sharply on the analysis of policy issues and, where feasible, discuss options for resolving those issues. I believe NSF is fully capable of identifying and drawing on the source materials to describe the most significant near- and long-term national policy issues associated with science and technology, particularly if, as anticipated, we continue to maintain close working relationships at the staff level with OMB and OSTP. We should be able to assemble in one place "strategic" information that can be used by both the Legislative and Executive Branches in the definition and discussion of significant policy choices. However, I doubt that the Outlook can be extended to a fullblown evaluation of options. Rigorous cost-effectiveness studies of alternatives may be suggested by the Outlooks or the Annual Reports—that would be one of their major contributions. But it would not be feasible for the reports to embody such studies because they involve very in-depth and time-consuming analytic processes.

Although we have not begun planning for Five-Year Outlooks beyond the second Outlook, we have thought a good deal about how future reports might best be scheduled for improved content and utility. As you know, legislation that has already been approved by the House of Representatives would require the Outlook to be prepared on a four-year cycle, with updates of the previous Outlook prepared during the interim. We believe this would be a reasonable way to proceed because it would give us more time to receive feedback on each Outlook, to think about the lessons learned and to try new approaches. It would also allow us to more sharply identify national scientific and technological shifts, trends, and discontinuities occurring between the preparation of each comprehensive Outlook.

We believe the Annual Report and the Five-Year Outlook can become important tools in discussions of science and technology policy questions. My colleagues and I also realize that we are still some distance from our goal of producing reports which provide the types fo systematic information required by Congress. We look forward to any comments, criticisms, and suggestions leading to improvements in substance and process.

I would be pleased to answer any questions.

Senator STEVENSON. Thank you very much, sir. I will invite our next witnesses to all come forward together and comprise a panel in order to try to save some time.

Dr. Gibbons, can we commence with you?

STATEMENTS OF DR. JOHN H. GIBBONS, DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS; DR. R. E. GOMORY, DIRECTOR OF RESEARCH, VICE PRESIDENT, IBM CORP.; AND DR. RUSSELL DREW, CHAIRMAN, TASK FORCE ON U.S. TECHNOLOGICAL POLICY, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Dr. GIBBONS. Thank you, Mr. Chairman. I have submitted my testimony for the record, and I present a short form to you this morning.

Senator STEVENSON. Your full statement will be entered in the record.

Dr. GIBBONS. I want to applaud at the outset the fine work of OSTP and its distinguished leader, Frank Press. That office has provided well-reasoned and effective leadership in the effort to insure strong support of scientific research and the appropriate utilization of technology to meet national needs. They deserve, I believe, a share of the credit for creating a national climate in which major scientific and technological advances are being achieved.

I would like to summarize my remarks in three areas: first, a few remarks on accomplishments of recent years; second, a short prospectus of science and technology; and third, a few comments on some policy implications.

Undoubtedly, you have already received a litany of some of the most fascinating recent development in science and technology. If I

had to prepare a short list, it would include first of all the explosion of knowledge in molecular biology—that is, how living systems work and especially how chemicals are manufactured inside cells under the supervision of giant molecules. Perhaps the most remarkable thing about this massive advance in knowledge is how fast it is being transformed into industrial processes and products such as human insulin and interferon.

Second on my list would be the continuing rapid evolution of knowledge about the nature of surfaces and near-surface interiors of solids and ultrathin layers of various materials. This knowledge which has come from surface physics and solid-state chemistry has been steadily absorbed by the semiconductor industry and has resulted in outstanding gains in product performance, in product reliability, in lower price of components such as computers, in telecommunications devices, solar cells, and many other applications.

Third on my list would be the rapid growth in understanding of the past history and the dynamics of our planet, especially the Earth's crust and its atmosphere. These advances have been translated into more effective methods to explore for energy and materials to predict earthquakes, to sense the critical influences on the atmosphere—influences which in turn affect the Earth's climate.

Another item is the further advances at both ends of the ultrascale of physical phenomena from subnuclear particles to planetary physics and cosmology. These studies, whether they produce direct products or not, help quench the human need for enrichment of the human mind.

Advances in science and technology do not come without cost, however. Recent research has also provided us with some very sober news about the limits that are imposed by nature. Our once heady thoughts about energy being "too cheap to meter" have clearly disappeared. The more recent euphoria over the "coal option" has been rudely tempered by evidence of the impacts of acid rains and the potential consequences of carbon dioxide on world climate. We still find just cause to exploit the coal option, especially in an era of undiminished social concern over the nuclear option, but this evidence has resulted in the choice of a cautious policy path.

On the other hand, on the demand side of energy, for example, there is the good news that the long-standing claims that economic and environmental benefits from research and technology investments in the efficiency of energy use are real and are beginning to become evident in a slowdown of demand growth.

In summary, events in science and technology over the past several years have reaffirmed the thesis that, properly managed, science and technology will continue to unfold new options for social choice. At the same time, we have witnessed strong affirmations of both the limits imposed by nature on the applications of science and the imperfect character of technology that emerges from science and engineering.

I would now like to spend a few moments concerning prospective views of science and technology. The 1980's will be a time of critical adjustment to a number of new realities, all of which have some direct connections with science and technology.

The realities include, first of all, rising resource costs and scarcities. These will include not only energy but water, land, and minerals—and will occur here as well as in other nations. As a result of the need for greater efficiencies in the use of resources of all kinds, we will experience an inevitable increase in the degree of interaction and interdependence within and between all sectors of our economy.

Second, I would note the rapid and major advances in the sciences which undoubtedly will continue to occur. In thinking about the next 5 years, it occurs to me that we should expect further rapid advances, especially in the microworld of molecular biology and exotic materials such as semiconductors, lasers, and composite materials.

For example, from molecular biology can emerge new options for chemical production, including pharmaceuticals. Also there is a good chance for improved genetic stock for the production of food and energy, and further health advances in treating illnesses.

Third, I would cite the increased problems associated with large-scale technology. These include the diseconomies of scale that such technologies may entail or may encounter in a time of rapidly rising costs of resources and capital equipment. These difficulties may shift our attention toward the development and use of technologies that are capable of decentralized implications and which make a more appropriate match to local resources and local needs.

I believe we are seeing a growing recognition that the world may be within a generation of the Earth's capacity to supply human needs and to absorb our wastes unless we radically change the way we have historically used our resources.

This means, at the bottom line, substituting human ingenuity through technology for the rich resources we are "running out of." It should be clear that developments in science and technology which can be expected over the next 5 years are not only impressive, but also imperative in maintaining our economic progress.

Numerous opportunities exist for innovative technology to be used as a leading tool to fight inflation—for instance, through increased productivity and to reduce the resource inputs, such as energy, that are required to produce goods and services.

Similarly, there are chances for new and improved amenities in areas such as telecommunications, health, education, and less pollution.

On the other hand, some difficult adjustments will clearly be necessary. Advances in computers and telecommunications will cause major impacts and challenges on educational needs and on educational institutions. Job displacement as well as job creation will inevitably occur. Applied molecular biology will undoubtedly provide options to manipulate life in new and controversial ways.

Improved efficiency in the use of resources will require new levels of interdependence and increased complexity between organizations such as utilities and industry.

And as technology developments accelerate, so must social accommodation. There are already signs that our rate of accommodation is stressed.

We need to monitor and analyze how well we are achieving our larger individual and societal goals. Motion is not synonomous with progress.

As the recent Global 2000 study points out, it is very easy to be pessimistic about the prospects of maintaining a steady pace of betterment for the human condition here at home and much less in the Third World. We must begin to wrestle more deliberately with the notion of building an economic system that can be sustained over the long term. This means learning the extent to which our present system, such as agriculture, is sustainable. And then directing our ingenuity to that end.

Finally, Mr. Chairman, with respect to some policy implications, it is of paramount importance that public policy create an environment to support research and properly guide the advance of technology.

This environment includes the nurturing and the development of skills and inquisitive minds. It includes long-term support of basic research and a cultural and an economic climate that encourages innovation and financial risk-taking.

The Federal Government policies that play major roles in this process include financial support of education and research. A regulatory environment that helps ensure competition as well as equity, and a tax system that is designed to foster investment and financial risk-taking.

It seems increasingly important to give closer attention to innovation in the way we organize, fund, support, and provide oversight to research and development.

Several observers have suggested that more direct links be forged between research and the industrial community. This re-emphasis of a relationship that has been stronger in our past, could lead to a more efficient use of capital than the alternative of using industrial tax revenue for federally funded and directed projects.

I think this could be fruitful in the areas of research and development that are specifically relevant to industrial interests. The potential benefits of such a close association between industry and academia transcend the issue of efficient use of capital, because the interpersonal relationships that can emerge via review and oversight, student co-op training, and the like, could enliven the people involved and multiply the effectiveness of the activity.

We need to experiment with new arrangements among our institutions, just as we need to be innovative in our laboratories. The ideas behind the CARP program, the ocean margin drilling program, the generic technology centers, may be an important example of just such experiments.

I might add that one nature of experiments is that many of them fail, but nonetheless, one learns from them.

Senator SCHMITT. It is hard to get a Ph. D. on a failed experiment, though.

Dr. GIBBONS. I could quote a few for you.

Great civilizations have been built through the exploitation of rich natural resources. Ingenious use of resources, such as energy and metals, has led to a nearly general obsolescence of traditional brute application of manual labor and has provided millions of

people with riches that are beyond the dreams of kings who lived a scant few hundred years ago.

Each generation, in using those resources, has an inherent obligation of intergenerational equity. There seems to be little evidence in our classroom, or in our laboratories, that we accept this responsibility fully.

Rather, we seem more intent these days in drilling for the last pool of oil or vein of ore, as though today were all that counts. A vigorous sustained R. & D. program is one of the few ways that we can provide equity to future generations.

Then where are the R. & D. frontiers? We deal simultaneously with both ends of the scale of things, from subnuclear particles and highly esoteric notions of symmetry to awesomely complex systems of atoms, molecules, and even organisms.

We conjure up theories and models and we test them with ingenious experiments. The two-way interaction of experiment and synthesis is a very powerful process.

I would also posit that there is a relatively underattended area of importance in terms of societal dynamics. That especially merits more support for experimentation and for synthesis.

This area lies at the next level of aggragation beyond organisms—our very social institution and modes of behavior. Social inventiveness—for example, the GI bill—has had incalculable impact, not only on our R. & D. activities, but on the whole fabric of our society.

One can readily argue that the limits that are imposed by natural law and even by technology on our ability to provide for human want and need, are not the biggest problem, at least not for the immediate future.

Rather, we seem more bounded by lack of understanding of our peculiarly human world, of our institutions and of conflict resolution in a pluralistic society.

Does this not then speak for research and development that complements the usual scope of technical R. & D. It represents a frontier of knowledge vital to our progress and to our very survival.

Thank you, Mr. Chairman.

[The statement follows:]

STATEMENT OF DR. JOHN H. GIBBONS, DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT

I am pleased to participate in these hearings to review accomplishments in science and technology over the past three years and to sketch the outlook for the next few years. Since part of OTA's responsibility is to keep an eye on both the status and the prospect for science and technology as they relate to federal policy, my comments today reflect not only my personal thoughts about the matter, but also to a considerable degree the insights that have been gained at OTA.

I want to applaud, at the outset, the fine work of OSTP and its distinguished leader, Dr. Press. The Office has provided well-reasoned and effective leadership in the effort to ensure strong support of scientific research and appropriate utilization of technology to meet national needs. OSTP certainly deserves a goodly share of the credit for creating a national climate in which major scientific and technological advances are being achieved.

1. Accomplishments

Over the past several years, breathtaking breakthroughs have occurred in astronomy, molecular biology, geophysical sciences, microelectronics, and a host of other areas.

Undoubtedly, the Committee has already received a litany of some of the most fascinating recent developments in science and technology. My short list would include:

An explosion of knowledge about molecular biology, that is, how living systems work, especially how chemicals are manufactured inside cells under the supervision of giant molecules. Perhaps the most remarkable thing about this massive advance in knowledge is how fast it is being transformed into industrial processes and products such as human insulin and interferon.

A continuing rapid evolution of knowledge about the specific nature of surfaces and near-surface interiors of solids, and ultra-thin layers of various materials. This evolution has been steadily absorbed by the semiconductor industry and has resulted in outstanding gains in product performance, reliability, and lower price of electronics, computers, telecommunication devices, solar cells, and the like.

Rapid growth in understanding of the past history and dynamics of the earth, especially its crust and atmosphere. These advances have translated into more effective methods to explore for energy and minerals, predict earthquakes, and sense the critical influences on the atmosphere that in turn affect the earth's climate.

Further advances at both ends of the ultra-scale of physical phenomena from subnuclear particles to planetary physics and cosmology.

Out of these developments in scientific knowledge emerge new technologies, often in a startlingly rapid time frame. The rate of advance of solid state electronics and optical devices is such that commercialization of new technical advances is limited by the rate at which we can absorb them into the economy. Information power available to individuals advances at a staggering pace. Analogously, the obsolescence rate of computer and telecommunication technology only a few years old is very high. In many instances there is essentially no delay between scientific discovery and its application in technology.

These advances do not come without cost, however. Recent research has also provided us with some sober news about the limits that are imposed by nature. Our once heady thoughts about energy being "too cheap to meter" have clearly disappeared. The more recent euphoria over the "coal option" as a supply-side savior has been rudely tempered by evidence of the impacts of acid rains and the potential consequences of carbon dioxide on world climate. We still find just cause to exploit the coal option, especially in an era of undiminished social concern over the nuclear option. This evidence has resulted in the choice of a cautious policy path.

We have also witnessed a loss of entrepreneurial risk-taking. Risk capital, virtually unavailable a half-decade ago, is once again available (in no small measure reflecting more sensitive taxation policies), albeit not to the extent that obtained during the heady days of the '60's. Furthermore, the small entrepreneur and individual inventor still find venture capital difficult to find and expensive to obtain.

On the other hand, on the demand side of energy, there is the good news that the longstanding claims of economic and environmental benefits from technology investments in energy conservation are real and are beginning to become evident in a slowdown of demand growth.

In summary, events in science and technology over the past several years have reaffirmed the thesis that, properly nourished, science and technology will continue to unfold new options for social choice. At the same time, we have witnessed strong affirmations of both the limits imposed by nature on the applications of science and the imperfect characer of our technology.

2. Relevance to social priority and need

One way to examine the accomplishments of science and technology policy is to see how they relate, for better or worse, to national priorities, such as national security, economic progress, and fulfillment of human wants.

National security.—Advances in technology continue to raise questions about the adequacy of existing military systems, and there are growing concerns that new weapons and new arms control agreements may be obsolescent by the time they become fully operational. Response to that situation is both expensive and imperative. It is increasingly clear that "security" goes well beyond the purely military dimension. Security is now seen to also include such questions as economic competitiveness, resource availability (today energy, and tomorrow perhaps scarce materials as well), and the planetary climate. We have discovered that we are on the verge of affecting climate on a global scale with plausibly dire consequences within a half-century. We have become more cognizant of the imperatives for improved U.S. competitiveness in international trade and also for decreased dependence on oil imports. In the case of international competitiveness, we can recognize that, although the U.S. still enjoys a technological advantage in many areas, there are few, if any, technologies in which the U.S. lead is not threatened by the relatively higher

investment of other countries in research and new plants and equipment. This recognition of the broader ingredients of national security is not being matched with commitments of resources to turn the situation around.

Economic progress.—The rapid rise in energy prices has hastened the economic obsolescence of much of America's capital stock. In addition, labor productivity improvement has not kept pace with increases in wages. These conditions place a heavy demand on capital markets; they also fuel inflation. Advances in technology, which have historically enabled us to fight inflation, are now needed in full measure just to help hold the line.

Human wants.—While the amenities humans may need or want are complex and vary with cultures and individuals, it is convenient to compare the relevance of technology to such basic wants as habitat, health, mobility, security, communication and satisfaction. Quite clearly, recent developments in science and technology broadly impact all of these areas. Traditionally, the application of science and technology, through engineering, has focused on the first five of the "wants" listed above. Improvements have been impressive. Certainly there is no perfect technology; any powerful idea or development can have untoward as well as beneficial impacts. Thus advancing technology in computers can at the same time make education easier, bookkeeping less expensive, displace jobs, and make war more terrible. The U.S. and other societies are now wrestling with the inescapable fact that no real world choice can be made without consequence. The direction of technology over the past several years has been strongly refocused toward providing amenities with fewer disbenefits and toward operations that can be effective in smaller scale. Such developments can be reviewed as an effort to rehumanize technology. The earlier trends toward larger scale of production brought benefits of lower costs but also the perceptions of disbenefits such as pollution, and loss of a sense of local control and sufficiency. The extent to which these efforts to apply additional criteria to the choice and shaping of technology may be successful is debatable, but the seriousness of the effort is both new and refreshing. It represents a responsiveness of the technology community to the sixth want (satisfaction).

3. A Prospective view of science and technology

The 1980's will be a time of critical adjustment to a number of new realities. Those realities include:

Rising resource costs and scarcities, including not only fossil energy but water, land and minerals. Society's adjustments to these rising costs will include efforts to protect, preserve and wisely use our natural resources as well as the development and use of new and more efficient technologies, industrial processes and patterns of land use and physical growth. As a result of the need for greater efficiencies in the use of resources of all kinds, we will experience an inevitable increase in the degree of interaction and interdependence within and between all sectors of our economy—agricultural and industrial, public and private. This greater interdependence is the direct result of the fact that the most promising options for increased efficiency involve actions which require that interdependence.

Rapid and major advances in the sciences.—In thinking about the coming five years, it occurs to me that we should expect further rapid advances in the microworlds of molecular biology and exotic materials such as semiconductors, lasers, and composite materials. From molecular biology can emerge even over the short span of the next 60 months whole new technological options for chemical production (including pharmaceuticals) and transmutation; improved genetic stocks for the production of food and energy; and health advances in treating illness and providing more effective fertility control. The past stream of options provided by advancing technology in exotic materials will continue, if not accelerate, and will appear via computers, telecommunication devices, energy effiency improvements, process control, solar conversion, and more.

Major demographic changes with increasing contrasts between a maturing population with a limited growth of new workers in the industrial world and the explosive growth of jobseekers in the "developing world," including our southern neighbors. In this country, the growing proportion of elderly in our population will require major shifts in social and health services. Migration from the South, especially the Caribbean Islands and Central America, will present the region with considerable challenges.

Increased problems associated with large scale technologies, including the diseconomies of scale such technologies may entail in a time of rising resource and capital costs and the vulnerability of complex and centralized systems to breakdowns of various kinds. These developments may increasingly turn our attention toward the development and use of small scale technologies that are capable of decentralized application and which make a more appropriate match to local resources used

needs. Along with the growth of such technologies may come a renewed emphasis upon local self reliance.

Recognition that we may be within a generation of the limit of the earth's capacity to supply human needs and absorb our wastes unless we radically change the way we have historically used resources. If the industrialized nations are to make the benefits of technology available to a world society and, at the same time, continue to improve their own standard of living and quality of life, then "elegance"—an increasing economy of means in the pursuit of desired ends—must replace brute strength as a basis for both technological and institutional change. The urgency of making this shift is underscored by the increasingly impatient drive of the less developed peoples toward a greater share of the world's wealth and by the growing realization that some groups of people have little hope of catching up without sharp reductions in population growth.

The Nation's success in adjusting to these realities will depend in large part on how carefully it weighs alternative strategies against two basic criteria:

(1) To what extent (how much and how soon) can our technically advanced society substitute human ingenuity for raw resources by relying increasingly on more sophisticated technologies and institutional innovations as ways to meet people's needs and provide their amenities?

(2) To what extent will the actions we are undertaking lead us toward a long-term sustainable economic system and environment?

It should be clear that developments in science and technology which can be expected over the next five years are not only impressive but also imperative in maintaining economic progress. Numerous opportunities exist for innovative technology to be used as a leading tool to fight inflation via increased productivity and to reduce the resource inputs (such as energy) required to provide goods and services. Similarly, there are chances for new and improved amentities in areas such as telecommunications, health, education, and reduced pollution.

On the other hand, some difficult adjustments will be necessary. Advances in computers and telecommunications will cause major impacts and challenges on educational needs and institutions; job displacement as well as job creation will inevitably occur. Applied molecular biology will undoubtedly provide options to manipulate life in new and controversial ways. Improved efficiency in the use of resources, especially energy, will frequently require new levels of interdependence (and therefore complexity) between different organizations such as utilities and industry. As technology developments accelerate so must social accommodation.

There are already ominous signs that our rate of accommodation is stressed. We need to monitor and analyze how well we are achieving our larger individual and societal goals. Motion is not synonymous with progress. As the recent "Global 2000" study points out, it is very easy to be pessimistic about the prospects for maintaining a steady pace of betterment of the human condition here at home, much less in the Third World.

Surely over these next five years, while supporting science and shaping out technology to foster economic and social progress, we must begin to wrestle more deliberately with the notion of building an economic system that can be sustained over the long term. This means learning the extent to which our present systems (such as agriculture) is sustainable and then directing our ingenuity to that end. It means thinking less in terms of escaping to other worlds and more hard thinking about stewardship and fulfillment on this planet. Unlike our heritage of rich natural resources, human ingenuity expressed through technology knows few limits. It holds the promises of heaven along with the perils of hell. We are too many in numbers to do without advanced technology and must therefore not only embrace it but also respect its limitations and power.

4. Policy implications

It is of paramount importance that public policy create an environment to support research and properly guide the advance of technology. This environment includes the nurturing and development of skilled and inquisitive minds, long-term support of basic research, and a cultural and economic climate that encourages innovation and financial risk-taking. The federal government policies that play major roles in this process include financial support of education and research, a regulatory environment that helps ensure competition with equity, and a tax system that is designed to foster investment and financial risk-taking.

It seems increasingly important to give closer attention to innovation in how we organize to fund, support, and provide oversight to R&D. Several thoughtful observers have suggested that more direct links be forged between industry and the research community. Properly orchestrated, this re-emphasis of a relationship that has been stronger in America's past could lead to a more efficient use of capital than the alternative of using industrial tax revenue for federally funded and direct-

ed projects. I think this could be particularly fruitful in areas of R&D specifically relevant to industrial interests. The potential benefits of such a closer association between industry and academia transcend the issue of efficient use of capital because the interpersonal relationships that could emerge via review and oversight, student co-op training, etc., could enliven and enrich the people involved. We need to experiment with new arrangements among our institutions just as we need to be innovative in our laboratories.

Great civilizations have been built through the exploitation of rich natural resources. Ingenious use of resources such as energy and metals has led to a nearly general obsolescence of traditional brute application of manual labor and has provided millions of people riches that are beyond the dreams of a handful of kings who lived a scant few hundred years ago. But each generation, in using resources, has an inherent obligation of intergenerational equity. Our obligation is to conserve our depleting physical resources with knowledge and wisdom. This must be our bargain with the future. There seems to be little evidence in either our classrooms or in our laboratories that we accept this responsibility. Rather we seem more intent on drilling even for the last pool of oil as though today is all that counts. A vigorous and sustained R&D program is one of the few ways we can be equitable across future generations.

Where are the R&D frontiers? We deal simultaneously with both ends of the scale of things—from subnuclear particles and highly esoteric notions of symmetry to awesomely complex systems of atoms, molecules and organisms. We conjure up theories and models and test them with ingenious experiments. The two-way interaction of experiment and synthesis via theory is a powerful process. I would also posit that there is a relatively underattended area of great importance in terms of societal dynamics that especially merits more support for experimentation and synthesis. This area lies at the next level of aggregation beyond organisms: our various social institutions and modes of behavior. Social inventiveness—for example, the G.I. Bill that followed World War II—has had incalculable impact, not only on R&D but upon the whole fabric of society.

One can readily argue that the limits which are imposed by natural law and even by technology on our ability to provide for human need and want are not the biggest problem, at least for the intermediate future. Rather we seem more bounded by lack of understanding of our peculiarly human world; that of our institutions and of conflict resolution in a pluralistic society. Does this not then speak for research and development that complements that of the usual scope of "technical" R&D? It, too, represents a frontier of knowledge vital to our progress and also our very survival.

Senator STEVENSON. Thank you, sir. Dr. Gomory.

Dr. GOMORY. Mr. Chairman, you already have my prepared statement. I would really like to supplement that with a few personal observations.

These statements relate to the 5-year outlook. What I would like to say is it is always difficult to describe the workings of a large and varied and complex enterprise, whether that is technical or not.

In the case of the 5-year outlook on science and technology, which is a vast field, there is the additional complication that the subject matter is technical. However, the size and complexity of the whole enterprise is the main issue.

If you want to have a useful way of summarizing and describing it, you really have to introduce the right set of concepts to deal with it.

Now to clarify what I mean by those abstract words, let me try to give a concrete example. In my ordinary work, compared to this sort of extraordinary work of the 5-year outlook, I am responsible for a research division of some 2,000 people in three laboratories, and in these laboratories, we have some 200 or 300 distinct projects.

It is absolutely necessary for us to describe our work in an intelligible way, both for our own internal planning, and in order

to explain to the company what we are doing in a way that is convincing and produces support.

Now, we have the information which would enable us, if we tried, to write a description of what every technical person does, but I think it is clear to anyone that such a document would be thick, unintelligible, and useless.

You might think next of describing various projects, which at least are coherent, technical entities, and, in fact, we do have a project book, and once it was quite important to us.

It was the description we used, but, in fact, that, too, is far too much information and too jumbled a presentation of what we do to be effective.

What would seem perhaps natural as a next attempt would be to deal with our administrative structure, in which the largest unit is a department; for example, a physics department, applied research department, and so forth. Departments are large units, and they are the units that we often work with in our daily work.

There are only eight of them, so that the number is not impossible to deal with. However, we have learned through experience that a plan or description of our activities, which consists of eight department plans hooked together, does not really work.

It turns out in practice that the departments are not always unified by a technical theme. They are there for historical reasons, for personal reasons, because they are manageable, and for many other reasons other than the fact that they are intelligible, comprehensible wholes.

What we have evolved to over the years is a set of concepts. And in these terms we describe the work of our research division. The concepts are different for various parts of our division, but they do seem to work.

We now have a plan which describes our applied work in terms of parts of a computer. In other words, it is organized to answer this sort of question, what are we doing in displays? What are we doing in the area or logic and memory?

This set of concepts—and we have about five categories—does not work for our basic scientific work, and we have to address those areas in terms of the basic area addressed.

For example, how are we doing in surface science, which we agree is a key area. Or polymers, which are also important to us.

With this conceptual structure, we have done much, much better.

I might point out that you need only the conceptual structure, but you have to work with recipients, and with our own people, to develop the appropriate level of detail in describing these things.

We also do our strategic thinking now in this framework. For example, in the area of displays, our basic strategy is to work on the existing technology, which, for example, in this case, is the cathode rays tube, and to run one radical alternative. And we found over the years that that is a good strategy, to not turn your back on the incumbent technology.

So these have become a framework for our thinking and for our description. And it works pretty well. It works a lot better than what we used to have.

We arrived at this framework—not that it is very deep and profound, but it did take a long time to evolve to it. And there was a process of trial and error and feedback.

We tended to try things to find out what worked, what was intelligible to ourselves in looking at ourselves, and what was intelligible to other parts of the company.

What I am trying to say is that I am not recommending these concepts as a conceptual framework for the 5-year outlook, but that we should pay a lot attention to an interactive process of improving the 5-year outlook now that we have a first pass at it.

And I think that what is needed, because the 5-year outlook is still in a process of learning, evolution, is finding the right concepts and talking to the people who are the recipients of the 5-year outlook and finding what was useful, what was not useful, what sort of question did not get answered, or what parts of the outlook appeared to you as simply long list, undifferentiated, of possibilities, what parts are unintelligible and where we simply didn't respond to what you wanted to know.

And I am really talking about fairly detailed discussions. For example, when we talked about the materials, we talked both in terms of three new materials to make high-temperature turbines blades and also about the fact that the U.S. materials' producers are becoming increasing dependent on foreign sources.

It would be useful for people working on further outlooks to know if you really want to know about the three materials? And did you also want to know about the dependence on foreign sources and to what level of detail, and so forth. I think this kind of interaction with the users, which I would take to be this group, is the way to evolve something that is usable in the long run.

Senator SCHMITT. What you are suggesting is in the conceptual definition of the 5-year or any year outlook, you force integration of one variable with another in your consideration of the concept. If you get too compartmentalized, as your other illustrations of what you rejected indicate, you don't have an integration.

In your latest example, the question of the way of designing turbine blades with the availability of the material with which you will build the turbine blade.

Dr. GOMORY. That is an example of the kind of feedback. I hadn't thought of it in the way you are describing it, but you might want to say well, now, are we going to be able to get those materials? Are they based on raw materials that you only get from Zambia, or something? And we didn't address that question.

That would be the kind of feedback to a 5-year outlook.

Senator SCHMITT. The conceptual categorization would not make any sense unless you followed it through to make sure you had looked at all of the variables that are going to allow you to do something as your end product.

Dr. GOMORY. I agree with that. What I am trying to say is the first pass—the first step has now been made. There is a 5-year outlook in existence, and it is now possible to critique it and improve it. I really hope that there will be a good deal of dialogue, fairly concrete and detailed, about what we have now. And I think that is the way in which you can hope to get really a much better document over the course of time.

Thank you very much.
[The statement follows:]

STATEMENT OF DR. RALPH E. GOMORY, STUDY CHAIRMAN, FIRST REPORT OF THE NATIONAL RESEARCH COUNCIL ON THE FIVE-YEAR OUTLOOK FOR SCIENCE AND TECHNOLOGY

Mr. Chairman, thank you for the opportunity to testify. At the request of Dr. Philip Handler, President of the National Academy of Sciences, I served as study chairman of the first report on the Five-Year Outlook for Science and Technology prepared by the National Research Council. For background, I am a mathematician, vice president and director of research of the International Business Machines Corporation, and a member of the National Academy of Sciences and the National Academy of Engineering. I provided my services to the Research Council as a volunteer, as indeed do all who serve on its committees. As you know, the National Research Council is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering, each of which was established to provide scientific and technical advice to the government.

The Academy's contribution is incorporated in Volume II of the National Science Foundation's formal report on the Five-Year Outlook, which was submitted to the Congress earlier this year. In addition, the Academy's report, delivered to the Foundation in March 1979, has been published separately by W. H. Freeman and Company.

A very brief history of how the Academy approached its task may be useful to the subcommittee. In 1978, the Foundation, after it was given responsibility by Reorganization Plan No. 1 for preparation of the Outlook, and also the annual report on science and technology, requested the Academy to provide a report that would describe the current state of research and also issues involving science and technology that may be of especial interest to the nation over the next five years. The Academy, in turn, sought both internal and external counsel in designing its response. President Handler and I, as well as other senior officials of the Academy, met with Senators Stevenson and Schmitt and the staff of this subcommittee to review our understanding of Congressional intent and our initial plans. At that meeting it was agreed that the Academy's report should be organized by scientific disciplines and problem areas rather than by governmental programs and structure. It was understood by all present that our report would be directed to only a limited selection of disciplines and societal problems and that, hence, a series of such reports would be required in order to accumulate a reasonably comprehensive view of the whole of science and technology. We also reviewed our plans, in September 1978, with the Directors of the National Science Foundation and the Office of Science and Technology Policy.

The actual contents of the report were shaped by the advice of different units of the Academies of Sciences and Engineering and the Institute of Medicine. These included, among others, the Council of the NAS, the Governing Board of the National Research Council, and the chairmen of the major units of the Research Council.

The request to the Academy encountered several difficulties: Those of any task undertaken for the first time; the obvious need to be selective, rather than comprehensive, and hence the omissions of some important areas of science such as chemistry and technologies such as transportation; and a demanding time table that, in practice, gave the Academy 8 months from commitment to delivery.

The contents of the report mirror the diversity of science and technology. The first three chapters are disciplinary portraits of basic research fields—of the fertile research underway in the earth sciences, much of it driven by the plate tectonics hypothesis and new tools such as remote sensing from space; of the continual advances in our understanding of molecular events within cells, and the application of that understanding to immunology, to the neurosciences, and to the biology of plants; of the continuing quest to understand the structure of matter, from the energetics that power x-ray bursters to the unification of the fundamental forces of matter.

The future course of these research fields will be in good part a deribative of current work. Therefore, in appraising the outlook for basic research, we deliberately sought in our report to portray as accurately as possible the current state of research, believing that to be a reliable prism for looking at the future. There are discontinuities, of course: Surprises or new insights that will open new fields or redirect a current research line. While, axiomatically, one can rarely anticipate them, one can try to assure that the system is such that they can be rapidly exploited.

Technology is more amendable to prediction, given the time needed to go from design through development to a product or process. And, indeed, the three chapters on technologies in the Academy's report—specifically, computers and communication, energy, and materials—are more assertive in stating their outlooks. We could, for example, write confidently that we will have million-bit memory chips by the mid-1980's, that costs per chip will consequently continue their decline, but that past improvements in device speeds will not be mirrored in the future without the introduction of new technologies. Similarly, when it turned to energy, the report could be quite explicit about the prospects for various supply technologies, noting that the only short-range options to replace oil are coal and conventional nuclear energy, with solar energy on a longer time scale. In its examination of materials science and engineering, the report was able to assert bright prospects for several classes of materials, such as the glassy metals.

The report further embedded its discussion of these technologies in a wider context: That of computers in the burgeoning, almost common use of computational equipment; energy, in the different decisions that have to be made to meet short-, medium-, and long-term needs; materials, in the increased dependence of the U.S. for non-fuel resources from other countries.

A similar contextual approach was taken in the next set of three chapters that deal with the interweaving of science and technology in issues pertinent to the United States. The chapter on U.S. demography uses a careful presentation of what demographic data does and does not tell us to bring out issues warranting attention, such as changes in the number and average size of households and the relation of population redistribution—north and south, central city and suburb—to changes in labor patterns and energy use.

The chapter on the health of the American people draws a picture of how far we have come and what needs now to be done. Samples of the latter include continuing the dramatic decline in cardiovascular disease rates; bettering our abilities to detect cancers, trace their causes, and prevent them; and dealing more vigorously with the medical problems of an aging population.

"Toxic Substances in the Environment" is the topic of the final chapter in the section specific to the United States. With recent events such as those at Love Canal in mind, a comment made in that chapter seems right for quoting: "During the next five years, we will come to know more about the nature, extent, and seriousness of the problems posed by toxic chemicals. Indeed, new problems may be uncovered. But as more knowledge is gained, we will learn how better to control, manage, and reduce toxic chemical hazards."

The last two chapters in the outlook report were on two settings in which science and technology is done: The research universities and international institutions. Members of this subcommittee will not be surprised to learn that it is extremely difficult to draw quantified portraits—or even qualitative ones that are generally accepted—of the state of institutions. Nevertheless, in looking carefully at academic science and graduate education, we found sufficient evidence for stating that the next five years will "be a time of adjustment for universities and academic science. . . ."

In the chapter on international institutions for the performance of science and technology, one of the key messages is that, rather than seeing the creation of new institutions, the emphasis will be on being more imaginative in using what we have. That seems to hold whether the topic is disarmament and national security, economic development, or environmental concerns of a global nature, such as the possible effects of rising carbon dioxide levels on climate.

This is obviously a very brief and selective commentary on a report that is itself highly selective. But I hope that it does at least give you its flavor and how we tried to carry out our charge given us by the National Science Foundation, and indirectly by the Congress.

We learned leassons in doing this report, some that may be of particular interest to this subcommittee and which, with your indulgence, I would like to share with you.

One is the sheer vigor of the scientific endeavor in the United States. While there are trouble spots, the contents of the Academy's first report, and that of the second in the outlook series now being written, testify to the breadth, productivity, and quality of American science and technology. One might ask whether any other single country could from its own community of scientists produce such volumes.

We also learned, as I indicated earlier, that the meaning of an "outlook" depends on the topic. If it is basic research, then those engaged in it are quite chary of offering outright predictions, preferring the more conservative stance of looking at research trends as indicators of what lies ahead. I share that view, but also believe,

as I stated earlier, that five-year outlooks are plausible and realistic when applied to technology already at the design stage.

A general rule in preparing the first volume—one also being applied to the second—was to omit recommendations of any sort. In effect, we insisted on an uncoupling of scientific and technical contents from policy considerations. We believe, in retrospect, that this decision was a wise one. It drew a clear line between the responsibility of the Academy and the Executive and the Congress. The Academy was to provide as accurate a picture as possible of the status of a field, one relieved of the need to argue for more money, institutes, changes in priorities, and so forth. The function of the government, in our view, is to use these portraits as the foundation for the formulation of policy. We think that a useful distinction and hope to maintain it.

We also believe that this separation of science from public policy was responsible, at least in part, for the extraordinary response of the scientific community when asked for help. That the volume exists, and whatever positive views you have toward it, reflects the work of the people who wrote its various parts and who reviewed the many drafts. Writers responded with vigor to urgent requests to write on the status of their own fields, to do it in a way intelligible to nonscientists, and to do it quickly. Reviewers for their part gave a great deal of their time—many devoting several days in reading and commenting on manuscripts—to a careful and judicious reading of manuscripts.

Finally, a few words about the outlook process as I perceive it. To my knowledge, it provides, for the first time, a means by which the Congress and the American people are informed in a continuing and comprehensive way of what is happening within the enterprise they so generously support. The consequence can only be a better informed electorate and ultimately better judgments on those matters in which science and technology have a part.

Mr. Chairman, that completes my prepared statement. I would of course be pleased to respond to any questions you and the other members of the subcommittee may have, and welcome suggestions of how it might be made more useful to those charged with formulation of policy.

Senator STEVENSON. Thank you.

Dr. Drew?

Dr. DREW. Mr. Chairman, I, too, would like to have you put the full statement in the record, and I will summarize that statement at this time.

Senator STEVENSON. Thank you. It will be entered into the record.

Dr. DREW. I will be discussing matters today that are both a reflection of my own personal experience in the Office of Science and Technology, Science Policy Office, and the Office of Science and Technology Policy, about 11 years total experience at that level; and also the views of the Institute of Electrical and Electronics Engineers, the world's largest professional engineering society with over 165,000 members in the United States alone, and over 200,000 worldwide.

The IEEE has taken formal positions which I will refer to in my summary of my testimony today. I would like to emphasize three major points. They are an outgrowth of the work of this committee and we have some complimentary remarks we would like to make to you, Mr. Chairman, for your leadership of this committee, and for its work in keeping science and technology policy matters alive and under some active discussion between the executive branch and the Congress. My remarks also reflect the interests of a very interested science and technology community.

Our remarks are intended to address the continued need for the type of dialog fostered by this subcommittee. In fact, we wish to reinvigorate the dialog, because I think we sense a certain lack of public exposure at the right levels in the last 3 or 3½ years following a rather important period when Public Law 94-282 was

taking shape, when there was a great deal of active participation and discussion of science and technology policy matters; a great deal of ferment, if you will, in the community.

I think we have seen that, perhaps, die out, and lack some of the vitality that was characterized by the debate that led to Public Law 94-282. We would like to see that debate reinvigorated, and we think there are some useful opportunities for doing that. We spell out some of those opportunities in the testimony, and I would like to call your attention to them.

No. 1, we looked at the question of the annual report and we share some of the concerns that have been expressed earlier about the nature of that document. And particularly, we support many of the findings—certainly the major findings of the recent GAO report and analysis which you asked for.

In considering how one might proceed from here, we are recommending—or actually supporting a recommendation that has appeared elsewhere, that rather than look for this annual science and technology report as the type of annual highlight of the major science and technology policy issues, that instead the science adviser and director of OSTP be asked to—or mandated, perhaps, in a modification of the law—appear before the Congress and provide something very much akin to the posture statement which is characteristic of the Defense Department in research and engineering, and for the Secretary of Defense.

Now, Dr. Press does appear before these committees at the beginning of the year. But what we had in mind was to expand the framework in which he presents this sort of annual posture statement and make it, if you will, more of an event. This will make his testimony more of a public document with more public participation in discussing the issues that are raised therein, perhaps engaging both the House and the Senate in support of such a public presentation.

And we have suggested this as a measure to, perhaps, be more effective in drawing out what you indeed, I think, need. And that is an annual report with more focus and more sense of priorities, as contrasted to the sort of documents that have been prepared.

I do not fault, nor do we fault, the institutions that have been responsible for those documents. But we think that you need something more than that. And the current process is not going to yield the type of focus that you in the Congress, and I think the larger community, needs to try to move science and technology policy in this Nation. And so that was one of our first recommendations.

Second, the board of directors of the IEEE has taken a formal position recommending that the United States give high priority to the development of a technological policy. Now, a full description of this will, I think, take too long at this point, Mr. Chairman, but I have indicated in my statement some of the major elements that we think are part of such a U.S. focus on technological policy.

Our recommendation is that the Congress and the executive branch (it will have to depend on the leadership in the Congress, however), consider establishing a commission, a joint executive-legislative commission, which would do two things; which would (1) focus on what we think is a very high priority need for this Nation and provide some degree of continuity of attention, something I

think that we see as a problem with the way the administration has treated the domestic policy review on industrial innovation. It was a one shot effort. We don't see the degree of continuity of attention that we think is important; and (2) this commission, I think, could also address the very important questions that were raised in title III of the act which, in the GAO report it was pointed out, have not been answered. The assignment to perform a survey to examine and analyze the overall context of the Federal science engineering technology effort and the rest of the text which describes that effort, has not, indeed, been carried out.

Now, the PCST, the President's Committee on Science and Technology, was abolished. I believe, and we agree with the GAO analysis, that it is timely to have that done and, lacking a commitment on the part of the administration and of the OSTP, I think the way to get it done is to organize such a commission with a focus on U.S. technological policy needs. And so we have recommended that as our second major recommendation.

A third point has to do with setting the agenda for the OSTP, that is, Frank Press' office. I feel one problem is highlighted by the fact that his testimony this morning had 30 pages of previous efforts, and only 3 pages focusing on the future. That is a problem. And I would just call your attention to work that was done almost 4 years ago. It is a report of the two advisory committees chaired by Dr. Simon Ramo and Dr. William O. Baker, the so-called Baker-Ramo committees. They were convened to address the issue of the future agenda for the OSTP.

If you look, in retrospect, at what OSTP has been involved with with over the past 3½ years, you will find that the issues track remarkably almost one for one with the major issues that were identified as the agenda for the office as it was recommended by those committees at that time. We are 4 years later now, and our recommendation is that such a formal agenda setting process be considered again. We recommend it be carried out, perhaps beginning in November, to try to focus on the next 4 years and the requirements in the way of a policy-setting agenda.

So together these three recommendations, Mr. Chairman, are all offered in the context of improving the focus of attention on science and technology policy issues.

We see some very specific needs and objectives. We have highlighted very specifically an item that has come up, but perhaps not as strongly, and that is the human resource needs as being very key. Dr. Gibbons has highlighted the natural resource limitations. We see some very important and serious questions dealing with the human resource limitations that will enable these policies to be carried out.

That is a summary of my comments. In the IEEE we are looking forward to taking an active role in the area of U.S. technological policy, and we stand ready to assist this committee in its efforts in this area in any way we can.

Thank you very much, Mr. Chairman.

[The statement follows:]

STATE OF DR. RUSSELL C. DREW, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

Mr. Chairman, it is a great pleasure for me to have an opportunity to appear before this committee on behalf of the Institute of Electrical and Electronics Engineers to testify on the subjects being examined here. As you may note from the biographical material provided with my statement, I have a special interest in the operation of the Office of Science and Technology Policy, having served in the previous Office of Science and Technology and then as the Director of the science advisor's staff when this function was assigned to the director of the National Science Foundation. My current role in the Institute of Electrical and Electronics Engineers is as the task force leader for U.S. technological policy, which is part of the strategic programs sponsored by the United States Activities Board of the IEEE. I will present views which reflect positions of the IEEE that have been given endorsement by its various entities and thus carry the weight of the nation's largest professional engineering society, with over 165,000 U.S. members. I will also present certain personal views and observations which reflect my eleven years' experience on the staff of the President's science advisor (beginning under President Lyndon Johnson) and my close contact with science and technology policy issues during the past three and one half years.

I should note at this point that we in the science and technology community are particularly pleased that your committee has given its attention to the implementation of Public Law 94-282 and to an examination of the ways in which we can work together to bring about more effective employment of our science and technology capacity to serve national goals and objectives. As you may recall, there was a high degree of concern that followed the dismantling of the former OST and the President's Science Advisory Committee, and this stimulated considerable re-thinking of the appropriate roles for such a function as part of the Executive Office. Although some would call this a dark period in the relationship of science and technology to the policy structure in the White House, it was a time of some very creative thinking on the subject, quite useful debate and discussion, and active consideration of the topic by this and other committees of the Congress. The resultant law and the structure it created represented a very major step in re-establishing and re-invigorating the S&T policy apparatus in the Executive Branch. It would have been very easy to mark that issue "closed" and move on, but recognizing the continuing, evolving, and growing needs of this nation which demand the very best we can obtain from the S&T enterprise, your current examination of the Science Policy Act (P.L. 94-282) and the larger question of the S&T policy agenda for the nation is timely and most appropriate. We must not allow ourselves to become comfortable with the idea that we have "solved" the structural relationships in such a critical area of activity essential to our national welfare.

This leads to our first recommendation, which deals with the desirability of fostering continuing debate and discussion of national S&T issues. In the Science Policy Act it was pointed out that:

"Comprehensive legislative support for the national science and technology effort requires that the Congress be regularly informed of the condition, health and vitality, and funding requirements of science and technology, the relation of science and technology to changing national goals, and the need for legislative modification of the Federal endeavor and structures at all levels as it relates to science and technology."

It was expected that the annual S&T report and the five-year outlook would serve to stimulate this process. The limitations inherent in the way that OSTP and the Administration have chosen to handle these two responsibilities have been well covered in the recent GAO report (PAD-80-79) in response to Senator Stevenson's request. We do not disagree with the major thrust of that report.

In order to address these concerns, and to benefit from the critical exposure that this subcommittee and its House counterpart can provide, we suggest the following action:

1. The Director of the Office of Science and Technology Policy should personally deliver annually to the Congress, through testimony at the beginning of the annual budget hearing cycle, a posture statement which reviews U.S. science and technology issues, particularly as reflected in the program and budget being presented for that year.

Such an opportunity would enable the Administration to highlight its major directions and responses to national needs and could serve as an alternative to the annual report required by the Science Policy Act. If we are realistic about our appraisal of the annual S&T report (and I am very familiar with how such reports are assembled), it is clear that—at least as it is currently approached—it will not meet the needs of the Congress or the public, nor will it serve to stimulate the

debate and discussion of S&T issues that we believe is important, both in building our understanding of them and in shaping actions to alleviate the problems that are identified. What you in the Congress need, I suggest, is not a compendium of all possible views and questions, achievements and agency pet programs, but rather a more concise, sharp, and highly selective set of issues together with some sense of priorities from the Executive Branch. The material provided should be in a form that is readily accessible and communicable to key members of Congress and their staff—it should not be buried in several hundred pages of material, however well constructed and reviewed by the agencies and the scientific community. I believe your needs as well as the larger public audience could be well served by an annual event, perhaps sponsored jointly by the Senate and House, the premier feature of which was the Science Advisor's annual posture statement. This could be followed by other inputs from major interested external sources such as the National Academy of Sciences or National Academy of Engineering, the American Association for the Advancement of Science, and the professional societies. It could include expert panels in specific areas or individual authorities in high-priority topical areas. In short, it could raise the intensity and visibility of the public discussion and debate about these issues. I might add, parenthetically, that in the past three years the quality and scope of such public and active involvement in issue development has diminished appreciably. I believe this has been, in part, because of a lack of highly visible opportunities for a discussion of views in a setting where the participation is at a sufficiently high level in the decision-making structures of the nation to make the efforts required to develop constructive views all worthwhile. In fact, it is in this area that OSTP has been, in my view, a great disappointment. Its inward looking role as an integral part of the White House apparatus, which is its top priority, has developed well and should be an achievement for which all the participants can be justly proud. But the Science Policy Act, and, indeed, the extensive legislative history behind the Act clearly indicates that there is an additional important outward-looking function that OSTP should perform. This function involves extensive consultation, interaction and dialogue with institutions and individuals as spelled out in Section 208 of the act. The highly visible involvement of OSTP in such processes can generate more interest and intensity in the responses from this community, the net result of which is a better informed OSTP, better equipped to do its internal job working within the Administration. This external interaction would not threaten Dr. Press' concern about the "need for confidentiality at critical junctures in the policy process," as he stated in his letter in response to the GAO report. But it would, in my view, restore a degree of vitality and focus to the current state of discussion regarding S&T issues in this nation.

A related issue, and one that was the subject of considerable comment by the GAO in its recent report on OSTP, is the question of how the agenda for the Office is determined and the lack of an approach to the identification of emerging issues. This is an area in which I have considerable personal interest and some direct involvement while in my previous official capacities. I would agree with the concern attributed to OSTP that there is a risk of developing information and assessments that go far beyond the capabilities and response characteristics of decisionmakers in the Executive Office of the President. Their focus most often is on fighting fires on a day-by-day basis, and they rarely have the luxury of stepping back and looking very far down the road or even at the broader context of their actions. But this restriction need not and should not apply to an organization such as the OSTP. It should be possible to carry out periodic agenda-setting reviews—the systematic horizon-scanning type effort, if you will—that can serve to enrich the OSTP staff data base without threatening their ability to work successfully within the Administration decision-making structure. There is an excellent example of this type of effort in the work of the two advisory groups in 1976, chaired by Dr. Simon Ramo and Dr. William O. Baker. The objective of these groups was to assist the newly emerging OSTP to establish its agenda. Their joint report identified a number of important topical areas, many of which developed into OSTP assignments over the last three years, including for example, the identification of industrial innovation as a major concern, recognition of new opportunities in earthquake prediction, the need for new policies and directions for space activities including particularly the applications area, the need for strengthening and broadening support for academic research, the provision of a better technical base for regulation, and more effective development of science and technology in the international context. In fact, the correlation between the recommendations of these two groups and the work of OSTP is remarkable in retrospect. Of course, while they did not mandate the agenda, these groups aided in building the perceptions of the issues and served to stimulate attention to the concerns they identified. It seems to me that an exercise such as the Baker-Ramo committees should be considered periodically—say every 3-

4 years. I believe, for example, it would make a very useful contribution to the work of the office over the next four years to have such a group constituted sometime in November of this year with a reporting requirement in the late spring of 1981. I believe the evident value of the previous efforts suggest that such a measure be given serious consideration.

Our second recommendation deals with the lingering issue, highlighted in the GAO report cited earlier, regarding the comprehensive report mandated by Title III of P.L. 94-282 and not otherwise reassigned to the NSF. In reviewing the national scene a few months ago, the Board of Directors of the IEEE unanimously supported a measure stating that "there is an urgent need for the United States to adopt a national technology policy." We believe our lack of commitment to a vigorous technology policy lies at the core of many problems that face us today and is a fundamental fact that should provide a starting point for the comprehensive review described in the Act. For a number of reasons, it seems clear that OSTP should not be left with the responsibility for this review. We suggest, that as an alternative, your committee consider the following recommendation: "A national commission be established, with members appointed by the President and the Congress, to conduct the comprehensive survey outlined in Title III of P.L. 94-282, with special emphasis upon the technological policy needs of the nation, and (as recommended by the president of IEEE, Dr. Leo Young) the status of the engineering profession in the United States. Specifically, this would include the supply of engineers, the quality and scope of engineering education, innovation and productivity in industry, the professional needs of engineers, and the possibility of a focal point for engineering in Government . . . that would be responsible for the creation of programs and policies and initiatives."

We offer this recommendation as a reflection of the IEEE position on the need for a comprehensive technological policy: (1) To enhance the continued development of technological knowledge through improved support of engineering research and encouraged cooperation between universities and industry; (2) To shorten the lead time between scientific discoveries and their application to the design of better products and processes; (3) To ensure the continued availability of skilled technical manpower, scientific and engineering talent, and the opportunity for a productive, rewarding lifetime career. (4) To ensure the continued utilization of our human resources essential to our nation's technological growth through effective personal incentives such as patent rights, portable pensions for engineers, and the assurance of the ability to work without regard for sex, race or age; (5) To restore the growth of productivity and enhance the formation of capital which will provide for the introduction of improved technologies and the replacement of obsolete facilities in industry; and (6) To reform regulations in order to balance costs against benefits and to create an effective focal point for technology planning which will encourage industrial management to increase their investment in our nation's capacity for production.

One of the subjects being examined today is the Five-Year Outlook, mandated by the act and published earlier this year. It is tempting to describe it as a monumental work because of its comprehensive nature and generally high-quality content. It will undoubtedly be of use to specialists and those who wish to pursue a specific topical area and gain insight into its future development and future issues. It does not, however, appear to be what the Congress was looking for when it mandated the report, and perhaps the need for a somewhat more limited focus and more easily encompassed set of issues can be satisfied in future updates of this document. For example, Dr. Atkinson's personal views in the introduction were very helpful and appear to be more in tune with the needs of the President and the Congress.

In viewing the Five-Year Outlook from the perspective of the IEEE, there is one area that stands out—consistent with our overall concern over a national technological policy—and that is the importance of the human resource base in science and engineering. The policies and programs that will move this nation forward and revitalize our industrial and educational institutions will depend upon our effective use of people, giving our best and most talented individuals the opportunities and incentives to become engineers and scientists, to become educated and trained to meet present and emerging needs, to have career recognition and benefits commensurate with their contributions to society, and to apply them to challenging tasks with the supporting infrastructure to accomplish them. We must not become complacent about this reservoir of skilled people, but continue to focus on their professional needs, for it is through their efforts that the goods and services upon which our national economy is based are produced. Increasingly we are being challenged and occasionally overshadowed by other nations in applying our technology. We must give special attention to the revitalization of our productive capacity, as part

of our effort to use the professional community that translates the work of scientists into the products we use and on which we depend for our quality of life.

This will not be easily or quickly accomplished, but we must continue to focus attention on our needs and on the definition of measures that move us forward toward meeting these needs. We believe that it will require a new form of cooperation between government, industry, academia and the engineering profession if we are to address this issue effectively and demonstrate a long-term national commitment to the continuing leadership position of the U.S. in the use and development of technology.

The IEEE will continue to give attention to the development of its views on technology policy issues and would be pleased to assist the Committee or its staff in addressing these important national questions.

In closing, it seems particularly appropriate to cite the words of Oliver Wendell Holmes: "I find the great thing in this world is not so much where we stand as in what direction we are moving: To reach the port of heaven, we must sail sometimes with the wind and sometimes against it—but we must sail, and not drift nor lie at anchor."

Senator STEVENSON. Thank you, sir. And I thank you all again. Those are positive, instructive, and helpful comments.

Dr. Gibbons, what is your opinion of the 5-year outlook and the process which produced it?

Mr. GIBBONS. In my own particular line of business, we find the 5-year outlook very helpful. In terms of an external view of the direction of major areas of science and engineering, 5 years, in many ways, is a very short period of time in terms of the evolution of scientific thought and its application in technology.

I have some concern about the need for translating the individual pieces about science and technology into some kind of a policy-relevant framework, and a need to include a greater discussion of the private as well as the public actors. I share your concern that I heard this morning, Mr. Chairman, about the locus of the work. Certainly I think the Academy of Sciences is a very important and very capable institution. The job of the Academy is to analyze matters specifically involving science and technology. I had the pleasure of serving on a number of Academy committees before I came to OTA. At the same time, I don't think that the Academy is necessarily the right place to try to integrate across particular subjects of study and relate them to national goals and priorities and policy goals and statements. That is a job that moves, as you pointed out this morning, closer to the offices of OSTP.

Senator STEVENSON. OTA is a project-oriented agency. I note you begin your statements, as I recall, with a passage that is entitled overview. Instead of being so project oriented, what would you think of requiring OTA to require its own periodic overview for the Congress? Maybe not so much as a—as the kind of statement of policy that we are suggesting for the administration, but an overview that helped the Congress to at least identify major policy questions that it would be or should be facing.

I should think this could build on the 5-year outlook. At least the work that goes into that might help to support OTA's own efforts to get the Congress a congressional overview. Is that worth trying to develop?

Mr. GIBBONS. I believe it is. Sometimes the best way to provide information is in the specific that follows from the general. I will be providing you next week, as a member of the Technology Assessment Board, with a short review as we look ahead into the next 2 fiscal years.

I would be delighted to have an opportunity to spend a little bit more time doing that kind of forward thinking, but not so much to tell the Congress what they ought to be doing because that is a fast way for me to lose my job and go back home.

Senator STEVENSON. A good way to get it not done.

Mr. GIBBONS. But rather to give the benefit of OTA's thinking as derived from its relatively unique situation of being the gathering place for the Congress of a lot of wisdom from around the Nation; from industry, from universities, and other places. For every project, OTA gather together the major parties of interest and hears them out. We then try to derive what we feel is the best judgment from that process. We submitted to Chairman Fuqua of the House Science and Technology Committee a review, at his invitation, of issues for the 1980's other than military and energy.

I would like to have more opportunities to do just what you suggested.

Senator STEVENSON. Can you give a little more thought to that general proposition, an OTA overview? As I think about it, and I am thinking about it the first time as is obvious, it might help us to critique the OSTP/NSF administration overview.

Dr. GIBBONS. It would provide us an opportunity to have a group from within the Congress give, as it were, an over-the-shoulder look at the prognostications provided from the executive branch.

One possible locus for the report could be the front end of the OTA annual report to Congress which is required by law.

Senator STEVENSON. Senator Schmitt.

Senator SCHMITT. I am intrigued that maybe a different approach along a conceptual concept might be even more useful. I have just scanned through the 5-year outlook but I admit I have not studied it. I also listened to some of your comments, Dr. Gibbons, and so much of what is in here is predicated on a concept of limits.

All of a sudden in the last decade or two, for unsubstantiated reasons, the U.S. science-technology policy community has made a fundamental assumption that we are running out of everything. Speaking as a geologist, and one with a fair amount of experience—there is no basis for that conclusion. There is no basis, in fact, for that conclusion with respect to our natural resource base or with respect to alterations and natural resource base.

But to a priori assume in a document like this that we must now have as a basis of everything else we do, the concept that we are running out of everything is a very serious mistake. The idea of working to evaluate this on a different framework of concepts that integrate these things would be very useful.

Dr. GIBBONS. I think that is a very important point, Senator. For more than a decade my sermons have been that we aren't running out of resources—we are running out of cheap resources.

Senator SCHMITT. Now, that is an a priori assumption, also. The cost of resources is a function of the supply.

Dr. GIBBONS. It is also a function of technology.

Senator SCHMITT. Exactly. There are any number of ways that you can drive costs down. But I bet it is written in here—I haven't looked for it—but I bet it is written that energy will never be cheap again. That is ludicrous. There is nothing in science technol-

ogy or just plain commonsense that says energy always has to be expensive.

The only reason it is expensive right now is because we let OPEC take over control of supply. Not because it costs OPEC any more than it ever did to produce it, inflation taken into account.

Dr. GIBBONS. One has to differentiate between the "lifting" or extraction cost and replacement costs.

Senator SCHMITT. Even replacement cost is inflated by about 50 percent right now.

Mr. GIBBONS. I appreciate your point about the——

Senator SCHMITT. Let's get away from the assumption that we are running out of everything, that there are no alternatives, that everything is going to be expensive. It just isn't true.

It is only true if we make it true, and we have been so far very successful in that particular policy, and that is making everything more expensive.

Dr. GIBBONS. The important issue that underlies your point is a thing we have not really begun to fathom at all—that the resources of human ingenuity as expressed through technology and through innovative ways of doing things. And that there is no evidence that says a properly innovative and creative society can't take care of these problems that come by having less access to very rich raw materials.

Senator SCHMITT. We had taken into account the innovation of the human mind when we restricted it. The regulatory structure of government, the tax structure of government, the withdrawal of lands from exploration, the lack of incentives for young people to go into science and technological and innovative fields in their education. The list is endless of everything we have done to restrict the innovative thrust of the American mind.

Patent policies themselves restrict that, particularly for small businesses, but also for large businesses.

Dr. GIBBONS. I am very pleased at your words. I am trying to get to the same points in parts of my testimony today. And, incidentally, Senator Schmitt, you may be interested to know that we are taking to our board, next week, a proposal to have a look at patent policy, specifically with respect to the smaller businessman and entrepreneur.

Senator SCHMITT. With the help of Senator Stevenson and Senator Cannon and others of this committee, this committee has reported out at least part of a solution, a uniform government patent policy.

Unfortunately, the administration has been fighting us on that and any number of other things. And my final comment is that when I heard the statement of Frank Press, and it goes to what was said by Dr. Drew, it is very difficult for the Congress to work in policy areas when the administration comes forward everytime and testifies that everything is rosy.

We are working on all the problems. We have a policy for everything. And don't worry about it, we will take care of it. And any time Senator Stevenson or I or anybody else comes with a suggestion that we may need a real policy in some area, they fight us at every turn of the road.

And, Dr. Drew, we are not going to get anything done in that kind of environment. I don't care whether it is this administration or any other administration. The cooperation in the legislation and policymaking process is a two-way street, and you can't have an administration that deals with the Congress with what at least this Senator believes is contempt in the policymaking areas.

We have gotten nowhere with any significant policy activities in the kinds of areas that we are talking about today. And every time some proposal is made, it is rejected by the administration.

Mr. Chairman, I don't know why we are voting today. Maybe they are trying to prove that there is not a quorum here. I thank the chairman for yielding.

Senator STEVENSON. I think it is a little unfair to imply that this administration is unique in its contempt for the Congress.

Senator SCHMITT. I hope by my qualifying statement I did not. I think they are very typical.

Senator STEVENSON. We agree. We usually do. All administrations share that contempt for this institution, and I have to say it is not entirely unwarranted.

Senator SCHMITT. Mr. Chairman, we are in agreement on that issue also.

Senator STEVENSON. As the Senator indicated, we do have another roll call. I think unless you have more, anymore questions, gentlemen, you are spared by the buzzer.

Thank you, very much. Your comments are helpful, and we are grateful. to all of you. With that, the subcommittee is adjourned.

[Whereupon, at 12:25 p.m., the hearing was adjourned.]

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

STATEMENT OF HON. ELMER B. STAATS, COMPTROLLER GENERAL OF THE UNITED STATES, U.S. GENERAL ACCOUNTING OFFICE

Mr. Chairman and members of the subcommittee:

In anticipation of today's oversight hearings, you asked GAO to review two functions of the office of Science and Technology Policy (OSTP) which was established in 1976 by Public Law 94-282. The first assignment was to examine the extent to which OSTP has covered the thirteen areas assigned for study to the President's Committee on Science and Technology (PCST) by Title III of Public Law 94-282. The second was to determine the extent to which OSTP is involved in strategic planning for U.S. science and technology, including any OSTP involvement in drafting the Annual Report and the Five-Year Outlook. You indicated that our study would be particularly useful if it could identify the constraints on OSTP in conducting this form of planning.

Mr. Chairman, we have completed this assignment and our report entitled "The Office of Science and Technology Policy: Adaptation to a President's Operating Style May Conflict With Congressionally Mandated Assignments" (PAD-80-79) was issued September 3, 1980. You have asked me to present a statement highlighting the issues in the report and also to include comments on the proposed changes in Public Law 94-282 regarding the Science and Technology Annual Report and the Five-Year Outlook as specified in the pending R&D Authorization Estimates Act (H.R. 7689).

TITLE III MANDATE

Title III of the National Science and Technology Policy, Organization, and Priorities Act of 1976 established the President's Committee on Science and Technology (PSCT). (The ten members of the Committee, nationally known figures from public offices, universities, industries, and research facilities, were appointed by former President Gerald Ford in October 1976.) Title III directed PCST to study broad issues in the organizations and management of science and technology and to report its conclusions and recommendations to the President within 2 years. The President was required to transmit the report with his comments to the Congress.

PCST was not permitted to complete its task, however. The first Reorganization Plan of 1977, as implemented by Executive Order 12039, abolished the Committee and transferred all of its reporting requirements to OSTP, except for the provisions regarding Government reorganization and Federal and State liaison that were delegated to the office of mangement and Budget (OMB). The Executive order required, further, that OSTP advise and aid OMB fulfill its assignments.

PCST's last official act was to record the results of the work that it had completed by the middle of April 1977. For most of the assigned topics, this report described the issue, provided background on congressional interest, identified principal subissues, suggested procedural options, and provided a list of potential resources and references. The Executive Director also submitted a memorandum to the Director of OSTP that briefly presented PCST's recommendations for disposing of each issue.

When assessing OSTP's handling of the Title III mandate, it must be recognized that OSTP is quite different from PCST. Unlike PCST, OSTP does not have a terminaton date nor a finite set of tasks. Unlike PCST, OSTP has an agenda that is fluid, and its operating philosophy is action oriented primarily toward current national policy issues involving science and technology rather than beign limited by a specific assignment. According to the legislative history of Title III of Public Law 94-282, PCST was established to study many of the same issues covered in Sciecne and Public Policy, a five-volume report by John R. Steelman in 1947. The Congress considered the survey report necessary because the direction of Federal science and technology policy had not been comprehensively studied in 30 years.

When we questioned OSTP on how it is fulfulling the Title III mandate, it responded with a list of many activities categorized according to the thirteen areas in Title III. The list (appendix II of our report) includes many topical studies that OSTP participated in. As seen from the list, much of OSTP's work does partially address the objective of Title III of Public Law 94-282, but we were informed by OSTP officials that the thirteen issues identified in the legislation do not directly

influence OSTP's agenda. The issues are so general to science and technology that almost any project OSTP could undertake would release to one or more of them. On several of the issues, OSTP's work is extensive. For example, OSTP's activity in the Domestic Policy Review of industrial Innovation, its interactions with OMB during research budget decisions, and its relationships with other Federal agencies, such as the National Science Foundation (NSF), the Department of Energy, and the Environmental Protection Agency, all pertain directly to the Title III mandate and appear to accomplish many of its objectives. However, OSTP does not intend to publish a comprehensive report on all 13 issues. At the same time, no systematic activity within OSTP ensures that it will examine all the issues assigned to OSTP after PCST was abolished. Thus, the Congress and the Nation are not going to have the current comprehensive document on science and technology that the Congress intended and expected.

We recommended that the Director of OSTP either prepare the comprehensive report originally mandated by Title III, or suggest legislation for the Congress that will relieve the Office of this mandate. We also suggest that the Congress consider whether such a comprehensive survey report of the Federal role in science and technology is still needed and, if so, what mechanisms other than OSTP could undertake it. We believe that transferring the Title III mandate to OSTP placed a large burden on it because the mandate significantly increased its responsibilities without increasing its resources. The mandate requires a comprehensive study, the preparation of which as intended to be the sole responsibility of an independent committee of nationally known senior individuals.

Your subcommittee may wish to explore these suggestions. Some believe that a combination of the Annual Report, the Five-Year Outlook, and other topical reports prepared by or with guidance from OSTP fulfill this need. Others may hold the view that a single comprehensive report prepared by an independent commission with detached perspective is needed to provide a foundation for comprehensive long-range strategic planning. We have not taken any position on these views.

If the Congress believes that a comprehensive study of the U.S. science and technology enterprise is still needed, I suggest that serious consideration be given to establishing a special statutory commission modeled after the Commission on Government Procurement, with a mandate requiring the executive branch to respond promptly to the commission's findings and recommendations. A central office—perhaps OSTP—could be responsible for coordinating responses of all concerned agencies and working with a congressional oversight committee—perhaps joint efforts of several committees—to develop legislative initiatives. GAO could monitor and periodically assess progress in implementing the commission's recommendations, as we did in following up on the Procurement Commission's recommendations.

STRATEGIC PLANNING

Overall U.S. strategic or long-range planning is dispersed among mission and regulatory agencies and other offices of limited jurisdiction within the executive branch. As a result, strategic planning efforts tend to focus on a relatively narrow issue or a broader collection of several related issues, usually within the purview of a single department or agency. It tends to be selective and fragmented. For example, one group of people might study the effective disposal of nuclear wastes. This might be broadened to an analysis of various aspects of nuclear power. A more comprehensive study, however, might consider all energy options—nuclear, coal, solar, and petroleum—while anticipating effects on the environment, international relations, transportation, communications, and basic research.

Strategic planning for science and technology tends to reflect the same Government approach which is divided along topical/mission areas. Thus, OSTP has chosen to effect incremental changes with an apparent long-term perspective, rather than conduct comprehensive or holistic studies that it believes would go unheeded. OSTP's pragmatic view is that, to be effective as a change agent, it should not waste resources by pumping out information that the decisionmakers of the existing Executive Office of the President cannot handle. OSTP is involved in strategic planning for science and technology in three major ways. OSTP initiates and participates in studies within primarily topical mission areas. It participates in the Federal budget process for research and development and related science and technology matters. It assists NSF in preparing the Annual Report and the Five-Year Outlook.

OSTP believes that its operating style enables it to effectively influence Administration policy. It regularly contributes significant technical expertise and advice that is strategically oriented. In our view, OSTP's influence stems from its willingness to work primarily within the existing decisionmaking framework of the Executive Office of the President, to ration its assignments of the sparse staff to areas

where they can have the most impact, to adopt issues as they are defined, and to act from its genuine conviction that science and technology resources should help the United States attain its national objectives.

OSTP staff see themselves as an active agent of change within the system. We asked Dr. Press how he will assess OSTP's effectiveness when he looks back on it 5 years from now, and he replied by listing several specific programs created or reorganized due to OSTP's prompting or influence. To be effective in the existing decisionmaking system of the Executive Office of the President, OSTP believes that it must respect the norms of the system. This affects its latitude in generating new issues, redefining existing issues, and most importantly, advocating change.

OSTP's current operating style is not the only one, however. A different staff might work differently. During the last 3 years, several knowledgeable individuals outside OSTP have sporadically criticized it for not doing enough work in three major areas. Critics say that OSTP should do more "horizon-scanning" or periodic and systematic assessments of new and emerging issues in science and technology. They would also like to see more holistic or comprehensive planning studies that bridge discrete or topically defined issues with an overall view of long-range or strategic plans for science and technology. Comprehensive studies could assess the interaction of presently defined issues and perhaps synthesize broad new strategies for anticipated issues. Finally, OSTP's critics would like to see more policies designed specifically for governance of the science and technology enterprise.

OSTP believes, however, that all such work would require various trade-offs. The present OSTP directorate believes that OSTP's resources are stretched very thin already and that taking on additional or different activities might diminish its effectiveness.

Certain constraints also limit the degree to which strategic planning can be done. One set of constraints is set by the characteristics of the Federal Government, another by attributes of the Executive Office of the President, and a third is set by some issues intrinsic to OSTP that would have to be recognized regardless of its operating style. Attached to this statement is a list of these constraints, taken from chapter IV of our report on OSTP.

We agree that the constraints in the present operating style of the Executive Office of the President inhibit OSTP's further involvement in comprehensive strategic planning and that in the present environment, OSTP would not be as influential as it is if it devoted most of its resources to comprehensive studies and reports. We believe, however, that OSTP not only gains its influence in the policy process by providing technical expertise in mission areas but also by offering a broad perspective on science and technology as a whole. Therefore, even if OSTP cannot do comprehensive studies, its selection of issues must reflect its broad understanding of how issues relate to each other and what they may mean for the future.

We are concerned that OSTP has no systematic process for identifying, assessing, and ranking issues. We do not agree with OSTP that it is sufficient to run an open office that entertains outside suggestions for OSTP work. We recommend that OSTP establish some formal mechanism for obtaining a detached view of issues for its agenda. The mechanism should help OSTP identify emerging issues, screen the many external suggestions for OSTP work, examine interrelationships, and suggest priorities that can be subjected to the professional judgement of the OSTP staff with regard to importance, timeliness, and feasibility.

We believe that the following three issues merit congressional consideration:

Should some other mechanism be established to identify and rank emerging issues in science and technology? Perhaps alternative mechanisms could help the Congress critically examine OSTP's selection of items for its agenda and its analysis of issues in the Five-year Outlook.

Does OSTP sufficiently balance its mission-related work by giving enough attention to (1) interactions and trade-offs among topical or mission-based strategies for science and technology and (2) Federal policies designed for the governance and support of science and technology?

How can the Congress and the OSTP Director best identify and resolve concerns about the Director's choices of operating style? Is the OSTP legislative mandate too comprehensive? What other means might fulfill congressional needs for information and analysis not provided by OSTP?

CHANGES PROPOSED IN H.R. 7689

Mr. Chairman, the last section of my statement is in response to your request for our view of the proposed change in science policy reporting requirements by H.R. 7689, the R&D Authorization Estimates Act. In brief, this legislation would delete the requirement for an Annual Report, require an updated Four-Year Outlook every two years (as opposed to the present annual requirement for an outlook), and

require that the Four-Year Outlook contain some of the information presently required in the Annual Report.

We agree that the annual requirement for an outlook should be relaxed to an update every other year. NSF does a tremendous amount of work in preparing each issue.

We believe that the Administration should present to the Congress a timely annual statement of some form on its posture and strategies pertaining to science and technology. The present annual report prepared by NSF does not fulfill this need. While the NSF view is important, the Director of NSF has limited purview of issues involving other Federal agencies. The Director of OSTP is the principal spokesperson to present the Administration's views on science and technology, and he does this in annual testimony to congressional authorization and appropriation committees.

The testimony by the Director of OSTP gives the Congress an excellent opportunity to question the Administration on its annual posture and strategies for science and technology. We believe that the present Director has performed this function rather well. If the requirement for an annual report were discontinued, the Director should make his statement available before budget or oversight hearings. This would facilitate analysis, comments, and questioning; additionally, the hearings and questions addressed to the Director of OSTP might be published under separate cover in place of an annual report.

In conclusion, we suggest that a more formal process of congressional/executive communications be established. Several attributes of this process exist that I want to mention here. Because it is not sufficient for the Administration to simply present its view of the issues and strategies, the Congress should press the Administration to justify its selection of issues and strategies. Questioning could draw from the work of the congressional support agencies and the analyses contained in independent reports (such as the excellent annual series on the Federal R&D budget by the American Association for the Advancement of Science). I do not wish to imply that this questioning need be antagonistic. Perhaps this subcommittee would find it helpful to go further than questioning the Administration after the fact. Perhaps a cycle could be established in which, each summer, appropriate congressional committees suggest issues they would like the Administration to address in the following season's testimony and statements. Sharing mutual concerns could enhance the congressional role in Federal science policy.

Constraints on Strategic Planning by the Office of Science and Technology Policy

Characteristics of Government That Constrain Strategic Planning

One constraint is the need to determine the balance between comprehensive or holistic strategic planning for all Government programs and planning for mission or topical areas.

Strategic planners must also ask whether some policy issues are more easily adapted to Government strategic planning than others. For example, the Federal Government exercises more leadership, has access to more of the necessary information, and has more control over some issues, such as national security and space, than over other issues vested primarily in the private sector. It is undoubtedly easier to do strategic planning for areas in which the Government exerts more control.

Finally, no matter what the issue, anyone who does strategic planning must consider the role of public participation in strategic planning.

Attributes of the Executive Office of the President That Constrain Strategic Planning

People who do strategic planning must balance strategic planning in the agencies with centralized strategic planning in the Executive Office of the President.

Another constraint is the need to determine the appropriate degree of congressional involvement in each stage of strategic planning and the extent to which plans should remain under the guard of the Administration's executive privilege.

Strategic planning must be structured to institutionalize a process that can transcend the tenure of a President in office.

Strategic planning must relate to the annual budget cycle.

ISSUES INTRINSIC TO OSTP THAT CONSTRAIN STRATEGIC PLANNING

First is the balance, and how the incumbents seek it, between OSTP's (a) contribution of technical expertise on known topical issues to the existing decisionmaking process, (b) analysis of interactions among strategies, (c) study of policy for science issues, and (d) role in identifying and redefining emerging issues.

Second is the need for a "countervailing" challenge of its choice of issues.

UNIVERSITY OF WASHINGTON,
Seattle, Wash., September 29, 1980.

Senator ADLAI E. STEVENSON III,
Chairman, Subcommittee on Science, Technology and Space,
U.S. Senate, Washington, D.C.

DEAR SENATOR STEVENSON: In response to a request from your staff, I am pleased to submit for the record a synthesis of critiques on the Five-Year Outlook on Science and Technology required by Public Law 94-282.

The evaluations were conducted by five university groups in science policy at the request by the National Science Foundation with the objective of obtaining suggestions for the next edition.

Exchange of the five critiques, coupled with discussion, revealed strong agreement on a number of major points:

In short, the organization and format should be improved next time by a more credible process of selecting priorities, standardized and crisper presentation of selected issues, extension of breadth of treatment beyond R. & D. of costs, constraints, alternatives, and a different sequence of preparing backup materials.

More attention should be given to congressional intent, especially of a policy orientation and attention to the future.

These prescriptions for an FYO more useful to the Congress raises, however, a fundamental question as to whether such a report could ever be prepared within NSF. No single agency is in a position to reflect the breadth of government activity represented by a fragmented bureaucratic enterprise. And no agency can reflect a perspective that crosses agency boundaries of mission and clientele to reflect a genuinely national view.

It was thus a consensus that only OSTP is in a position to prepare the mandated FYO. This coincides with the original congressional viewpoint. That is, the reporting process carries with it the potential for OSTP to strengthen its role as S and T advisor to the President and to the Congress.

NSF should be congratulated for this first effort and for the courage displayed in seeking advice on future preparations. NSF should continue in a key role in developing relevant materials. However, the report itself should not be a reflection only of an assessment by the Director of NSF, but of the President.

I trust you will find this material of value as you consider amendments to the National Science and Technology Policy, Organization and Priorities Act of 1976.

Sincerely,

EDWARD WENK, Jr.,
Professor of Engineering and Public Affairs.

Enclosure.

SYNTHESIS OF CRITIQUES BY FIVE UNIVERSITY GROUPS IN SCIENCE; POLICY ON THE 5-YEAR OUTLOOK, ON SCIENCE AND TECHNOLOGY

Introduction

The National Science and Technology Policy, Organization, and Priorities Act of 1976 (PL 94-282) called for annual preparation of a Five-Year Outlook as an aid to those responsible for designing national policy and as an aid to planning ahead by the many individuals and groups involved in technical enterprise. It was to "identify and describe situations and conditions which warrant special attention within the next five years. . . ." Responsibility for preparation was initially assigned to the Director of OSTP, but by Reorganization Plan No. 1 of 1977, that responsibility was transferred to the Director of the NSF. The initial product, released in May 1980, comprised two volumes. The first included a statement by the NSF Director and a synthesis of materials included in the backup second volume. The latter publication included a comprehensive description of selected fields of science prepared by the National Research Council and papers from 21 federal agencies and 14 consultants.

In an unprecedented initiative by the National Science Foundation to solicit independent feedback on ways and means of improving effectiveness of the seond FYO, five university groups were requested to critique the first report.

Represented were: University of Texas, Austin—LBJ School of Public Affairs; Washington University—Department of Technology and Human Affairs; George Washington University—Graduate Program in Science, Technology and Public Policy; Georgia Institute of Technology—Department of Social Science; and University of Washington—Program in Social Management of Technology. Each group submitted a 20-page analysis to NSF. Then, on August 22, authors met in Seattle with representatives of NSF and other governmental units to synthesize findings and thus to provide a potentially compact and coherent collective response to the assignment, in order to assist NSF in enhancing effectiveness of future editions of the FYO.

This paper constitutes a synthesis of discussions.

Primary findings

Exchange of the five critiques, coupled with discussion, revealed strong agreement on a number of major points:

1. Effectiveness of the FYO should be judged by its utility as an aid to decision making in technology-laden public policy, with Congress regarded as primary client. That is, it should be policy oriented.

2. A future orientation is fundamental to increasing probabilities that technical initiatives will lead, in the long run, to socially satisfactory outcomes.

3. Content and style should reflect legislative history, goals, and themes of the 1976 Science Policy Act—especially that satisfactory social performance of science and technology requires harmonizing technical with economic, managerial, legal and political processes.

4. Constraints or barriers to achievement of goals may involve inadequate technical knowledge, but significant shortfalls may also result from institutional malfunctioning, imbalance of long- with short-run strategies and other defects in those non-technical processes associated with technological enterprise.

5. Topics and issues selected for emphasis should be based on consistent criteria of choice.

6. Rationales and facts to support key issues should be cross-referenced to supporting documentation, including publications beyond Volume II especially prepared for the FYO. To encourage brevity and strengthen relevance, backup documents should be prepared after major substantive themes are selected.

7. Analysis of selected issues should be structured both by topic and by cross-cutting factors common to a number of substantive areas.

8. Options for policy action should be identified, together with estimated consequences of each.

9. Recognition must be accorded the conspicuous role in the totality of S and T activities of R and D and technological management associated with military security.

10. Connections should be established between the issues selected for emphasis and the state of technical knowledge required for resolution and associated R&D budget trends.

11. The FYO should represent a coherent, government-wide perspective. Therefore, the Outlook should be formulated at the level of the Presidency and should be considered an occasion at that level to highlight the key challenges and opportunities that lie ahead. It should be recognized also as an opportunity to enhance public understanding of complex issues facing society.

Discussion of findings

Underlying the points of agreement just cited, there was consensus by the five independent analyses that future editions of the FYO should be greatly strengthened.

To elaborate, government is today involved in all significant science and technology activities: to stimulate, to regulate, to provide direct support, or (as in the military) to act as customer. Policy initiatives by government thus represent primary steering mechanisms of society in turning technical knowledge and know-how to social purposes. Our greatest challenge thus lies in making wise choices at the highest level of government. That role is reflected in the title of the 1976 Act and in many of its provisions. The FYO was mandated as one of several mechanisms to facilitate such choices, but the intent of the legislation underscores the need for the FYO as an instrument of policy- rather than of program-level planning; i.e., it should be directed toward clarifying goals, setting priorities, allocating resources.

An unprecedented feature of the legislation is its future orientation, the recognition that steering requires looking ahead for crisis avoidance. Technology has demonstrated a capacity to produce unintended, unexpected, and sometimes unwanted effects, and consideration needs to be injected of long- as well as short-term consequences. Moreover, threats to survival and to our creed of freedom may be increas-

ing. The 1976 Act called for a policy of anticipation, in providing for assistance to the President in reducing surprise and in reducing the social and economic costs of short-sightedness. The price for not looking ahead is high. For example, a decade ago the nation possessed the ability to forecast the imminence of energy dependence and the consequences. Yet serious attention to conservation did not begin until years after the OPEC embargo; and that effort is still wobbling as the result of an unconcerned electorate. The FYO should lend credence to the need for and value of early warning, set the tone and give specifics for more effective anticipation in policy design through identifying trends to be considered as portents ahead, and through recognizing the tenets of strategic planning.

This means reporting on evolving technical developments, and also on "current and emerging problems of national significance" which have potential for use of technically based remedies. This, of course, requires a breadth in point of view that reflects technology as an important ingredient of modern life and social process. Most important is a reflection as to what constitutes technology (as far more than R/D), how it involves all institutions in our society, private and public, federal and local, and how, because of its potency, it operates politically.

That broader understanding then leads to recognition that many disappointments in contemporary technical enterprise result not from inadequate technical knowledge but from non-technical constraints or impediments in the social, economic, legal or political processes—influences of single-issue politics, domination of short-run profit considerations in industrial management; an adversarial climate; citizen frustration that finds an outlet in excessive environmental zeal, etc. To formulate methods for overcoming such barriers is admittedly far more difficult than is planning for research to fill gaps in knowledge, but this makes it especially important that the barriers be candidly recognized in an FYO.

Because the future is inevitably uncertain, because there are so many different forces tugging and hauling politically, and because each issue is so complex, the Congress wanted an office high and central in government to sort out what is critical from what is merely important. This implies a selection of topics for emphasis in the FYO based on some uniform criteria as well as a process that engenders credibility. This may be the most important part of the FYO preparation. Indeed, because of competition for attention and for scarce resources, such selectivity among the phalanx of pressing issues may be the only route toward reaching hard decisions. The FYO provides a unique opportunity for the Executive Branch leadership to enunciate the major problems immediately ahead and to provide the facts and analysis to facilitate better public understanding.

Analysis should be standardized. A suggested structure is to follow the organization of the Budget. Each topic should include discussion of the state of readiness of the relevant S/T, with appropriate reference to backup materials. Issues which are identified as important should be subjected to cross-cutting analysis focused on accountability, lack of public understanding, flagging innovation, R&D priorities, long lead times, risks, etc.

Problem identification, while necessary, is not sufficient. There must be identification of courses designed to provide escape from our dilemmas. What should we do, why and how? Seldom are such courses unique. Thus, alternatives for action should be presented in the FYO, among other reasons, to raise the level of debate from the parochial pleas of vested interests. And finally, the impacts of each should be discussed, especially in terms of risks.

The credibility of priorities asserted in an FYO is intimately related to current or projected funding patterns. Both public and private sources should be considered. In particular, the priorities identified by the FYO should be discussed in relation to defense funding; both the contribution of non-defense R&D to defense objectives and the contribution of military R&D to non-defense objectives should be considered.

Conclusions

All of these findings by the five groups of science policy analysts add up to deficiencies in the first FYO. In short, the organization and format should be improved next time by a more credible process of selecting priorities, standardized and crisper presentation of selected issues, extension of breath of treatment beyond R&D of costs, constraints, alternatives, and a different sequence of preparing backup materials.

More attention should be given to congressional intent, especially of a policy orientation and attention to the future.

These prescriptions for an FYO more useful to the Congress raises, however, a fundamental question as to whether such a report could ever be prepared within NSF. No single agency is in a position to reflect the breath of government activity represented by a fragmented bureaucratic enterprise. And no agency can reflect a perspective that crosses agency boundaries of mission and clientele to reflect a

genuinely national view. NSF can deal effectively with its role in R and D, but it is unrealistic to expect it to reflect the substance and subtleties of policy process developing centrally and extending significantly into economic, legal, social and political realms.

It was thus a consensus that only OSTP is in a position to prepare the mandated FYO. This coincides with the original congressional viewpoint. To assign the responsibility to OSTP may appear to add a cruel burden associated with the mechanics of report preparation. This assignment would, however, assist OSTP to fulfill the broader range of its potential missions. It would inject into OSTP functions the integrative and longer-range planning functions essential for OSTP to perform as intended by Congress. It should aid OSTP in its responsibilities to distill government-wide priorities and to resolve interagency conflicts. That is, the reporting process carries with it the potential for OSTP to strengthen its role as S and T advisor to the President and to the Congress.

NSF should be congraulated for this first effort and for the courage displayed in seeking advice on future preparations. NSF should continue in a key role in developing relevant materials. However, the report itself should not be a reflection only of an assessment by the Director of NSF, but of the President.

The 1976 Act explicity referred to the role of S and T in securing peace, economic viability, an adequate supply of strategic resources, strengthened health care, rebuilding of our cities, environmental conservancy. A stronger FYO could be a significant contribution to decisions ahead toward those goals.

O